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ABSTRACT

This document presents the Alabama State Department of Education minimum programs for science for grades K through 12. Programs are listed in two sections: K-8 and 9-12. Each listing includes: (1) a brief outline of life science, physical science, and earth science for the grade level, K-8, or for the science course, K-12; and (2) a detailed listing of concepts, desired learning outcomes, and activities. A listing of alternative content areas is also supplied. (SL)

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ALABAMA COURSE OF STUDY

SCIENCE

April 1977

Bulletin 1977, No. 6

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ALABAMA COURSE OF STUDY

SCIENCE

Wayne Teague
State Superintendent of Education
Alabama State Department of Education
Montgomery, Alabama 36130

April 1977

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SECTION ONE - INTRODUCTION

INTRODUCTION

The accelerated pace of scientific discoveries in the modern world and the increasing and technological applications of these discoveries have had a tremendous impact on the culture of today. In any democratic society the role of education reflects the needs of that society. Hence, American education serves society and does much to mold the thinking of each succeeding generation. To the extent that the American culture changes, so does the emphasis on the educational system.

By the end of the eighth grade, each learner is expected to have mastered certain minimal concepts in various areas of science; but, just as important, the learner is also expected to become aware of his surroundings in order to develop a value system to enhance his life-style. There should be a shift in emphasis from the cognitive domain toward the integration of the cognitive with the affective as the student progresses through the science curriculum.

Never before in the history of mankind has there been a greater need for all segments of society to become active participants in resolving issues in the environment, technology, population, and countless other areas. Since many students drop out before completing high school, the eighth grade may be the last exposure to any formal training in science; therefore, it is essential that students are prepared for issues which may have far-reaching effects on their lives. They will become contributing citizens who are required to vote on certain issues; to participate in local, state, and national decision-making; and to select vocations which will deal with problems of the environment and technology. Therefore, the science curriculum should be planned to reflect a growing concern for the issues of science, technology, society, and their interrelationships.

To the basic activities in subject-matter areas, objectives should be added to develop student potential and interest. Activities such as science fairs and field trips provide opportunities for the recognition of personal achievement of students in individual research and for the utilization of community resources, people, and materials in group learning. These activities aid in the development of scientific skills and in the mastery of content and concepts upon which high-level cognitive thinking can be built.

Science is an integral part of the curriculum and is one of the required courses in grades K-8. One unit of science is required for graduation; hence, any science course in the curriculum after the completion of grade eight would fulfill this requirement. For this reason it is suggested that courses not be locked into a particular grade level nor that any course be considered a required course in grades 9-12.

There are many scientific laws, principles, and theories that are prevalent in all science courses and curricula. Science does not have absolute proof to verify such laws, principles, and theories. It is therefore necessary that teachers and students approach the study of science with open minds.

American teachers have the responsibility of upholding human rights, among these being freedom of speech, press, and religion. Teachers therefore present scientific methods of inquiry and scientists' theories, including theories of creation of life and matter. Teachers also present accounts of Creation from Genesis and other books. At the same time teachers honor each student's right to believe in the religious teachings of his home and/or church.

It should also be remembered that reading is an integral part of any course. Although it is not intended that science be made a reading course, there are certain study skills that are peculiar to the area of science and should be considered in lesson planning and instructional implementation. For further information concerning these skills please refer to the bulletin, "A Mini-Guide to Reading in the Science Area," available from the Basic Sciences Section, State Department of Education.

CURRICULUM OBJECTIVES

After completing the science program, the students will demonstrate scientific competencies by being able to:

1. Organize and evaluate laboratory data effectively,
2. Use appropriate problem-solving techniques,
3. Work cooperatively in groups,
4. Communicate through oral and written expression,
5. Handle equipment, materials, and organisms in a laboratory setting,
6. Observe and record data,
7. Predict the effect of known causes,
8. Establish causes from known effects,
9. Interpret data and draw conclusions,
10. Plan and carry out tests of hypotheses,
11. Devise new experiments,
12. Use appropriate controls in laboratory experiments, and
13. Utilize science concepts and knowledge to enhance daily living.

The process skills of science are the skills necessary for effective "sciencing" and are used by the students to gather information, thus enabling them to build concepts about the world in which they live. Through skill development students build proficiency in locating, organizing, recording, transmitting, and evaluating information; and they acquire a means of refining thinking.

PROCESSES

Observing: Observations are made in a variety of ways, using one or several of the senses.

Describing: A description is recording an observation in words, numbers, or pictures.

Classifying: Classifying is the grouping or ordering of objects and events according to a scheme devised by the observer.

Inferring: An inference is a statement developed from a set of related observations. Inference requires evaluation and judgment.

Predicting: Prediction is the formulation of an expected result based on past experience. The reliability of prediction depends upon the accuracy of past observations and the ability to make inferences from a set of observations.

Measuring: Measuring is the determination of the magnitude of selected properties. The units of measure can be arbitrary or standardized.

Communicating: Communication is the process of describing, recording, and reporting experimental procedures and results to others. For clarity, tables and graphs may be used.

Interpreting Data: The interpretation of data requires that a student assess the validity, precision, and usefulness of data.

Formulating Questions: Questions are based on observations and usually precede attempts to evaluate a situation or event. They usually arise from inferences and give rise to predictions which must be tested.

Experimenting: Experimenting involves designing data-gathering procedures and then gathering the data needed to test a prediction. Variables must be identified and controlled as much as possible.

Planning or Organizing: Planning or organizing involves integrating data, experiences, and information into future projections in a rank-ordered sequence.

SECTION TWO - MINIMUM PROGRAM FOR SCIENCE IN GRADES K-8

SCIENCE FOR YOUNG CHILDREN: AN INTRODUCTION TO THE KINDERGARTEN CURRICULUM

Our everyday world is filled with phenomena that can be categorized broadly within the curriculum area of science. Sounds, colors, plants, animals, food, and weather are but a few of the topics that are included.

In considering an approach to present science for kindergarten children within the framework of a course of study, it is most important that those who will use this publication understand that the following section is but a brief outline of science concepts and learning activities appropriate for five-year-olds. Each teacher is expected to enrich the recommended curriculum in a creative way.

Operating on the premise that young children learn best through active involvement, the topics presented may be usefully presented in classrooms through incidental and planned learning opportunities. Since the five-year-old is naturally curious, he possesses those attributes that are important in the study of science. The everyday experiences of children in their environments provide an important relevance for them and help them make sense out of their world. The integration of science with other areas of the curriculum enable children to experience important relationships that are common to everyday occurrences.

With the understanding that each teacher possesses a unique capacity for the creative teaching of young children, the following examples of science topics, concepts, and activities are presented as a beginning only:

Animals
Insects
Plants
Soil
Rocks
Shells
Foods
Colors
Sounds
Magnets
Weather
Wheels
Water
Air
Senses

KINDERGARTEN

I. LIFE SCIENCE

A. Animals
  1. Uses
  2. Reproduction
  3. Need for food
  4. Movement

B. Plants
  1. Reproduction
  2. Need for light and water
  3. Uses
  4. Different kinds

II. EARTH SCIENCE

A. Air
  1. Air around us
  2. Uses of air

B. Energy from the Sun

C. Uses of Soil

D. Weather and Seasonal Changes

III. PHYSICAL SCIENCE

A. Matter
  1. Forms of matter
  2. Identification through the senses
  3. Changes in matter

B. Magnets
  1. Attraction
  2. Uses

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. LIFE SCIENCE		
A. Animals		
1. Animals provide people with food, clothing, and other products.	. Students will study, identify, and name some products we get from animals.	. Collect pictures and make booklet of animals and what they produce.
2. Animals reproduce babies that grow up to look like the parents.	. Students will match baby animals with the parent.	. Using pictures, let the students match the pictures of mother animals with their young. Note changes that occur with growth.
3. Animals eat different foods.	. After related experiences, children will be able to match animals with the food they eat.	. Visit a farm to observe feeding of animals. Cut pictures of animals and food from magazines and practice matching.
4. Animals move about in different ways.	. After appropriate activities, students will be able to move like the animal named.	. Play animal movement game or "May I."
B. Plants		
1. Seeds of plants will produce like plants.	. After activities and discussion, students will match seeds with correct plants.	. Examine samples of many plants containing seeds. . Match seeds with plants.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Plants need light and water.	. Students will name two things that plants need for proper growth.	. Plant seeds and watch plants grow from the seeds. . Students grow two plants for a week; stop watering one; observe what happens. Grow two more plants; water both; put one in light and the other one in the dark. Observe and measure growth. Draw conclusion about the conditions of each plant.
3. Plants are used in many different ways.	. After study, students will recognize ways in which plants are used for food, clothing, and shelter.	. Students will bring to school pictures of plants used for food, clothing, and shelter. . Discuss uses of plants in daily lives. List plants used in a meal. Identify use of plants in things around us such as pencils, paper, desk, buildings, and landscapes.
4. Trees are plants.	. After discussions and observations of pictures, children will identify trees from smaller plants.	. Bring in pictures of trees and smaller plants. Let children classify pictures. . Study the environment of the school and community and identify large and simple plants.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
II. EARTH SCIENCE		
A. Air		
1. Air is everywhere.	. Child will prove that air is everywhere.	. Fill a container with rocks. Pour water over rocks. Watch air bubbles appear.
2. Air is used in many ways.	. Children will demonstrate simple uses of air.	. Let children sit on an inflated toy. Let air out to observe difference.
B. Energy from the Sun	. After appropriate activities, children will become aware of the effects of light and heat from the sun on other objects.	. Put ice cube in sun and one in shade and observe effects. . Experiment with mirrors by reflecting light from the sun on various objects.
C. Uses of Soil	. Children will be able to distinguish differences in soils by observing and feeling. . After appropriate activities, children will identify things that are dependent upon soil.	. With several kinds of soils, put layers of soils in bottles to illustrate differences. . Take nature walk for observation. . See films.
D. Weather and Seasonal Changes		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
1. Every day has weather.	. Children will be able to draw pictures and describe weather conditions.	. Teacher will describe different weather conditions and have a student make or draw pictures showing the conditions.
2. There are seasonal changes.	. Children will be able to identify pictures depicting the four seasons.	. Keep daily weather chart. Use pictures to show the daily weather.
	. As the seasons pass, children will identify changes.	. Use bulletin boards, books, and films about weather and clothing.
III. PHYSICAL SCIENCE		
A. Matter		
1. Matter is commonly found in three forms.	. Given several samples of matter, pupils will classify the samples into solids, liquids, and gases.	. On a table place 9 or 10 samples of matter. Have pupils group the samples.
		. Have pupils identify the forms of matter seen in the environment.
2. Matter can be identified through the senses.	. Given two objects, children will distinguish shape, size, and texture.	. Blindfold three children; give each an object. One at a time, have him describe his object and name it.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. Given jars with two different smells in them, children will distinguish between the two and identify the smell.	. Give students some baby food jars with holes in the lids, containing such materials as perfume, fruits, leather, wood, or spices.
	. Children will be able to discern color and size by sight, given objects of shapes to organize according to some criterion decided upon by themselves.	. Children name colors of the paper and place the shapes into groups according to color.
3. Changes occur in matter.	. Given necessary materials, the children demonstrate that changes occur in matter.	. Make a gelatin or a pudding.
	. Children will be able to demonstrate the difference in appearance and taste of the same uncooked and cooked food.	. Let children make applesauce; discuss the feature of the apple and then the applesauce.
B. Magnets		
1. Magnets will pick up only iron and steel objects.	. Given a metal object of any size or shape, the child will distinguish between the magnet and its effect on iron and steel objects and its effect on regular metal objects.	. Lay out materials such as wood, paper, cotton, cloth, paper clips, and nails. Using the magnets, children will determine which objects a magnet will pick up.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Magnets are used in many ways.	. Pupils will demonstrate the use of magnets in their everyday lives.	. Show how magnets may be used in puppet plays. . Bring examples of magnets that are used on refrigerator and metal cabinets for notes. . Examine toys with magnets.

FIRST GRADE

I. LIFE SCIENCE

- A. Plants
  - 1. Kinds of plants
  - 2. Environmental influences
  - 3. Reproduction of plants
  - 4. The effects of pollution on plants
- B. Animals
  - 1. Kinds of animals
  - 2. Environmental influences on animal life
  - 3. Reproduction of animals
  - 4. Effects of pollution on animals
  - 5. Use of the senses

II. EARTH SCIENCE

- A. Space
  - 1. Light and heat from the sun
  - 2. Revolving of the earth
  - 3. Space, size, relationship
- B. Seasons and Weather
  - 1. Seasonal changes of weather
  - 2. Adaptation to seasonal changes

III. PHYSICAL SCIENCE

- A. Matter
  - 1. Identification of matter
  - 2. Changes in matter
  - 3. Conservation of matter
- B. Energy and Machines
  - 1. Use of energy
  - 2. Making work easier
  - 3. Use of magnets

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. LIFE SCIENCE		
A. Plants		
1. Many different kinds of plants are found on earth.	. The child will be able to tell the names of some plants in his immediate environment.	. Take a walk around the school grounds. Observe and discuss the different kinds of plants which children see. After returning to the room, encourage children to recall the plants they observed as the teacher records.
2. Plants differ in size, shape, color, and texture.	. The child will be able to describe a plant as to size, shape, color, and texture.	. From a collection of real plants or pictures of plants, ask children to classify them according to likenesses and differences.
3. Plants grow in many different places.	. The child will discover that plants grow in many different places.	. Plant terrariums representing the seashore, the woodlands, and the desert.
4. Plants need sun, air, soil, and water to grow well.	. The child will discover that plants must have sun, air, soil, and water to grow well.	. Plant seeds in three containers. As soon as the plants are growing well, put one in a closet but continue to water it. Stop watering one but leave it in the sun and air. Place seeds on a sponge and keep damp. Observe results and compare with plant given all it needs.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
5. Plants reproduce their own kind.	. As the child observes the growth of plants, he will discover that plants reproduce like plants.	. Carrots and radishes mature relatively quickly. Plant some of these seeds in early fall or in spring. Buy seeds with picture on the envelope. When plants mature, compare plants with picture of plants on envelope.
6. Pollution of land, water, and air can be harmful to plants.	. The child will discover through experimentation and observation that pollution can be harmful to plants.	. Spray oil on a healthy plant and observe the results. . Observe the condition of plants, trees, and shrubs growing near a heavily traveled road. Compare the condition of these plants with those growing some distance from the road.
B. Animals		
1. Many kinds of animals are found on earth.	. The student will be able to classify animals as to kinds.	. Ask children to collect pictures of animals and bring them to school. Discuss them. Let small groups take turns classifying them according to categories.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Animals are living matter.	. The child will be able to identify characteristics of living matter.	. Have children observe a living animal and a toy animal. As they observe, let them make comparisons and conclusions.
3. People are animals.	. The child will be able to identify characteristics which people and other animals have in common.	. Ask the children to compare the likenesses and differences between themselves and a dog or kitten. Make lists of the differences and likenesses so that children may see the many similarities.
4. Animals change as they grow.	. The child will identify some changes which occur as growth takes place.	. Using pictures of parents and their babies, have children observe and identify differences. (If possible, use live animals.)
5. Growth can be measured.	. Using measuring instruments, the child will measure growth.	. Using a measuring tape and scales, have children measure and weigh each other. Record measurements. Several months later let children measure and weigh each other again. Compare with previous measurements.
6. A proper diet is necessary for healthy growth for all animals.	. After discussing what balanced meals are, the child will be able to help construct a balanced menu.	. Use the cafeteria menus for a week to help children become aware of contents of a balanced meal. Then as a group, let children help construct a balanced menu.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
7. Animals live in many different places.	. After observation and research, the child will be able to identify a variety of animals' homes.	. Prepare a bulletin board using children's art, illustrating different animals' habitats. This activity may be used to categorize various animals.
8. Animals reproduce their own kind.	. After a discussion of his own pets and other animals in his immediate environment, the child will be able to identify parents and their own babies.	. Children will write stories and/or draw pictures of their pets and their babies if they wish. Other children may draw pictures of any animal and its parent.
9. Pollution of land, air, and water is harmful to animals.	. The child will become aware of the value of natural resources and the need to conserve them.	. Use a filmstrip or story (Bambi) to illustrate how a forest fire affects animals, plants, and people. If possible, invite a Forest Ranger or Smokey the Bear to talk with the children.
10. The senses are used for learning.	. The child will discover that his senses help him to learn.	. Have children close their eyes and listen quietly to the sounds they can hear. After about one minute have them open their eyes. Teacher will list all the sounds which the children are able to recall. Use additional experiments which make use of the other senses.

CONCEPTS	DESIRED LEARNING OUTCOMES	ABILITIES
II. EARTH SCIENCE		
A. Space		
1. The sun provides the earth with light.	. Through observation of the sky in the day and at night, the child can see that when the sun is in the sky more light is present.	. Have children observe and compare the sky in the day and at night.
2. The sun provides the earth with heat.	. Through the use of a thermometer the child will be able to measure heat given to the earth by the sun.	. Put a thermometer in the direct sunlight and another in the shade. The child can quickly and easily see the results of heat from the sun.
3. The sun seems to move across the sky during the day.	. Using a stationary light to represent the sun and a rotating globe to represent the earth, the children can see that the earth, not the sun, is moving.	. Let one child stand still holding a flashlight labeled "Sun." Let another child hold a rotating globe of the earth illustrating the motion of the earth.
4. Many objects are seen in the sky.	. Children will be able to identify objects seen in the sky.	. Observe the sky during the day and at night. Discuss observation. Children may make notebook of observation.
5. Large objects appear small when viewed from a distance.	. When viewing two objects of similar size, one near and one at a distance, the child can	. Take the children outside. Choose two children nearly the same size. Have one child

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	observe that the one at a distance will appear smaller.	stay with the group while one goes a good distance away. Have children observe child near and far and compare appearance of size.
B. Seasons and Weather 1. The weather changes in autumn, winter, spring, and summer.	. The child will become aware through firsthand observation, research, and the use of measuring instruments, such as the clock and the thermometer, that the temperature and weather changes in autumn, winter, spring, and summer necessitating adaptations by people, animals, and plants.	. A daily chart may be kept recording the kinds of weather shown over a period of time. Changes do occur sometimes causing severe weather; therefore, safety measures must be practiced.
2. The temperature changes in autumn, winter, spring, and summer.		. A daily chart of the temperature may be kept in graph form so that the children may see changes in temperature each day.
3. People adapt to weather and temperature changes.		. Have children observe changes necessary in their dress, play, and food habits so that they will be aware of changes people must make in adapting to weather

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		and temperature changes as well as seasonal changes.
4. Animals adapt to weather and temperature changes.		. During each season take field trips of the immediate environment, do research, and discuss changes and adaptations which children see in people, plants, and animals each season.
5. Plants adapt to weather and temperature changes.		
III. PHYSICAL SCIENCE		
A. Matter		
1. All materials on earth are matter.	. The child will be able to identify many kinds of material as matter.	. Children will collect a variety of pictures from magazines. The pictures will be placed on a bulletin board titled "Matter."
2. All matter occupies space.	. Pupil will discover that visible and/or invisible matter occupies space.	. Partially fill a jar with water. Drop marbles or rocks into the water and observe the water level rise as the rocks occupy some of the space in the jar.
3. Air is a real substance and takes up space.	. Pupil will discover that air is a real substance and takes up space.	. Pour water into a jar partially filled with very dry soil.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Observe bubbles of air come to the surface as the air is replaced with water.
4. Matter differs in size, shape, color, weight, texture, odor, and temperature.	. The child will be able to classify matter as to size, shape, color, weight, texture, odor, and temperature.	. Using the pictures collected for the "Matter" bulletin board, have the children classify them as to shape, size, color, etc. They will discover that some have many characteristics.
5. Matter is commonly found as solids, liquids, and gases.	. The child will be able to classify matter as solids, liquids, and gases.	. After reading about and discussing matter as solids, liquids, and gases, ask each child to bring one sample of matter to school. Let the children classify the matter.
6. Matter can change form.	. The child will observe changes in matter.	. Use water, steam, and ice to illustrate changes in matter.
7. Matter should be cared for and used wisely.	. The child will be aware that natural resources are useful to man, but they can be depleted or changed to a state which is not useful.	. Let children tell as many uses of wood as they can so that they will be conscious that wood is useful. Then burn a small piece of wood. Have children observe the remains and determine if the burned wood is useful.

CONCEPTS	DESIRED LEARNING OUTCOMES	ABILITIES
B. Energy and Machines		
1. Energy is needed to move things.	. The child will discover that energy is needed to move things.	. Ask the children to examine objects around them which move to determine what causes the motion. In each case some sort of force must be applied. In the discussion develop the concept that machines make work easier for us. . Visit construction area and observe how machines make big jobs easier.
2. Machines work for us.	. The child will discover that machines are used to do many kinds of work.	
3. Wheels help to move things.	. The child will discover that wheels make work easier.	. Have a child try to lift a box of heavy books. After much difficulty and effort on the part of several children, provide a wagon or wheel barrow into which the books are put. Children should observe how the job was made easy.
4. Magnets move some things.	. Using magnets and a variety of objects, the child will separate the objects by determining	. On a table place several kinds and sizes of magnets and many objects. Be sure to include

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	which can and cannot be moved by a magnet.	objects which a magnet will and will not move. The children will use the magnets to discover the objects which the magnet will move.

SECOND GRADE

I. LIFE SCIENCE

- A. Animals
  1. Kinds of animals
  2. Adaptation of animals to their environment
  3. Interdependence of plants and animals
  4. Endangered or extinct species

II. EARTH-SPACE SCIENCE

- A. Air
  1. Properties of air
  2. Air around us
  3. Air pressure
  4. Air for life
  5. Polluted air
- B. Water and Oceanography
  1. Abundance of water on earth
  2. Properties of water
  3. Temperature of water
  4. Moving water
  5. Water for survival
  6. Polluted water
  7. Plants and animals found in water
- C. Weather
  1. Atmospheric changes
  2. Observing weather changes
  3. Living things and seasonal changes

III. PHYSICAL SCIENCE

- A. Heat and Light
  1. Reflection or absorption of light
  2. Sources of heat and light
  3. Materials which transmit light
  4. Artificial light
  5. Helpful and harmful effects of fire
  6. Heat energy
- B. Magnets
  1. Magnetic force
  2. Making magnets
  3. Uses of magnets

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. LIFE SCIENCE		
A. Animals		
1. There are many kinds of animals on the earth.	. The child will be able to name and describe a variety of animals and compare them for similarities and differences.	. Children draw or cut out pictures of animals and group them in ways they may be alike--large, small, body covering, number of feet, shape of bodies, etc.
2. Animals survive in habitats that differ greatly.	. The pupil will be able to observe and describe the characteristics of animals that live in certain environments and to draw conclusions about the types of animals that might survive in a given environment.	. Group sees filmstrip or film of animals and habitats. Make a diorama, poster, or movie box about animals and habitats.
3. The dependence of animals and plants upon each other for food is called a food web.	. The child will be able to plan and construct a food web display, using data gathered through the study of this unit.	. Make a bulletin board food web display with data and pictures collected during this study.
4. Some animals have become endangered or extinct.	. The pupil will be able to name animals which have become endangered or extinct and list ways in which he can help prevent others from becoming the same.	. Look for pictures of extinct animals to show classmates and discuss. Also show filmstrip of Endangered Species.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
II. EARTH-SPACE SCIENCE		
A. Air		
1. Air is invisible, odorless, tasteless, colorless, takes up space, and has weight.	. The child will be able to use his senses to describe the characteristics of air.	. Children use a balloon or an inflated bag to show the difference in size and weight before and after inflation. They may also observe if they saw, tasted, or smelled the air as it went in or came out of the articles.
2. Air is found in water, soil, rocks, and above the earth.	. The child will be able to carry out activities that show air is everywhere.	. Pour water over a can of loose soil and a can of porous rock. Observe the bubbles caused by the water pushing out the air.
3. Air pushes in all directions.	. The child will observe and describe that air pushes in all directions.	. Make a parachute with large tissue, string, and rock. Observe how it floats because of the air pushing upward on it.
4. Air can be compressed.	. The pupil will be able to demonstrate how air can be compressed.	. Put the hose of a bicycle pump in a small container of water. Push handle and observe bubbles. Lift handle and place finger on end of hose (still under water). Push handle down again to show that air is compressed.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
5. Air can be used to help us work and play.	. The child will observe ways that air can make work easier.	. Make a pinwheel to show effects of moving air upon it. . Discuss and/or demonstrate air at work: air to make tires roll easier; air in vacuum cleaners to remove dust and dirt; air to dry hair and clothes; air to pump water, move sail boats, and kites.
6. Living things need air to survive.	. The child will learn the different ways by which living things obtain and use air--lungs, moist skin, gills, or spiracles.	. Let children observe themselves, frogs, goldfish, and grasshoppers to detect ways of obtaining air.
7. Polluted air can damage living as well as non-living things.	. The student will be able to identify the causes of air pollution and plan activities to increase others' awareness of the problem.	. Collect pictures and make a class notebook of things that pollute. . Use an industry in your area. Have someone talk to the class about pollution causes and control in the community.
B. Water and Oceanography		
1. Much of the earth's surface is covered with water.	. The child will become aware that much of the earth's surface is covered by water.	. Use a globe to compare areas of land with areas of water.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Water in its pure state is a colorless, tasteless, odorless liquid.	. The child will be able to tell differences between pond and distilled water.	. Compare pond water with distilled water to see differences.
3. Water exists in solids, liquid, or gaseous forms. It changes form by adding or removing heat.	. The child will be able to observe the three states of water when heat is added or removed.	. Place a cube of ice in a container. Observe the ice melt and evaporate.
4. Water takes up space and has weight.	. The child will demonstrate that water takes up space and has weight.	. Weigh an empty beaker and record its weight. Fill the beaker with water and weigh it. Compare weights.
5. Water dissolves many materials.	. The child will be able to carry out activities to observe that some solid substances dissolve in water.	. Children collect materials at home and school to see which will dissolve in water.
6. Moving water has force and can do work.	. The pupil will observe that water moves things.	. Put a pinwheel under a stream of water and observe how the water turns the wheel.
7. Water is used for recreation.	. The pupil will appreciate having water to provide recreational facilities for swimming, boating, skiing, and fishing.	. Share experience stories about fun with water; stress water safety.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
8. In the water cycle, water moves from the earth's surface into the air and back again.	. The child will be able to observe, describe, and explain the importance of the water cycle to man.	. Heat water in container on hot plate until it boils. . Hold a metal spoon above the boiling water to show condensation.
9. Water is constantly changing the surface of the earth.	. The child will be able to observe evidence that water is moving or has moved soil and rocks.	. Take an observation trip around campus and note evidence of washing away of soil. Gather and observe rocks which have been worn by water. Discuss how erosion can be stopped.
10. All living things need water to survive.	. The pupil will be able to plan and carry out an experiment to show what happens to a plant if it is deprived of water and to tell some of the many ways in which animals use water.	. Have children find out how many cups of water they drink in a day. Allow a plant to become dry enough to wilt; then observe what happens after water has been given to the plant.
11. Polluted water or water that contains impurities can damage living as well as nonliving things.	. The child will be aware of the causes of pollution and draw conclusion about ways to prevent this.	. Review information gathered on air pollution and use for water pollution. Plan a bulletin board, "How We Can Help Keep Water Clean."
12. Many plants and animals live in the water.	. The child will be able to identify some plants and animals that live in the water.	. Show films or filmstrips on plants and animals that live in water. . Visit a pond.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Weather		
1. Weather includes all the daily changes in temperature, moisture, wind, and air pressure.	. The child will become aware that weather conditions change daily.	. Use weather instruments to measure the weather conditions and record data over a period of several days.
2. Observation is an important part of predicting coming weather.	. The pupil develops an awareness and appreciation of weather forecasts which enable us to prepare for adverse weather conditions or plan for future activities.	. Ask pupils to listen for forecasts and check on the accuracy of these forecasts. . Have children to observe and make their own observation.
3. Seasons affect living things.	. The pupil will understand that plants and animals are affected by seasonal changes.	. Examine plants at different times of the year and note changes. Examine your pet's coat during the winter. Compare its coat in winter and summer.
III. PHYSICAL SCIENCES		
A. Heat and Light		
1. Light can be reflected.	. The children will observe that light can be reflected.	. Place a mirror in the sunlight; observe the reflection.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Many objects that give off heat also give off light.	. The child will be able to observe and describe possible sources of heat and light.	. Use a lighted candle to show it gives off heat and light by putting hand near to feel the warmth.
3. The earth receives heat and light from the sun.	. The child will be able to observe and describe the familiar scene changes from day to night.	. Have pupils to stand in the shade and in the sun. Compare the difference. Use a filmstrip or films showing that the earth's light comes from the sun.
4. Light passes through translucent and transparent materials but does not pass through opaque materials.	. The child will be able to sort or classify objects with respect to how they transmit light.	. Make a mystery box in which children put objects that are transparent, translucent, and opaque.
5. Artificial light is produced in many ways.	. The child will be able to identify sources of natural and man-made light..	. Make a display of man-made and natural sources of light.
6. Heat energy has many useful applications.	. The child will be able to see that heat energy is used to meet many of man's needs.	. Pop popcorn in the classroom.
7. Fire is very valuable yet very dangerous when it is not controlled.	. The child will be able to describe how fire is useful, how it may be dangerous, and how one might follow safety precautions in a fire emergency.	. Have children help plan a visit to a local fire station. List questions about fire fighting equipment and safety precautions to use if trapped by a fire.

THIRD GRADE

I. LIFE SCIENCE

- A. Animals
    - 1. Classification of animals
    - 2. Survival of animals
    - 3. Interdependence of plants and animals
- B. Plants
    - 1. Basic needs for growth
    - 2. Growth cycle
    - 3. Nongreen plants

II. EARTH SCIENCE

- A. The Sun and Solar System
    - 1. Planetary movements
    - 2. Rotation and revolution of the earth
    - 3. Rotation of the moon
- B. The Earth
    - 1. Changes in the earth
    - 2. Composition of the earth
- C. Rocks and Soil
    - 1. Characteristics of rocks
    - 2. Formation of rocks
    - 3. Composition of soil
    - 4. Conservation of soil

III. PHYSICAL SCIENCE

- A. Machines and Their Uses
    - 1. Simple machines
    - 2. Complex machines
    - 3. Friction and lubrication
- B. Matter and Energy
    - 1. Characteristics of matter
    - 2. Classification of matter
    - 3. Causes of physical changes
- C. Sound
    - 1. Vibration
    - 2. Characteristics

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. LIFE SCIENCE		
A. Animals		
1. Scientists have classified animals.	. Identify animals as mammals, reptiles, amphibians, birds, and fish.	. Collect pictures of animals and classify them.
2. Many different kinds of animals live together to make up animal communities.	. Classify meat-eating animals and plant-eating animals.	. Compile a list of meat-eating and plant-eating animals in your community. Collect or draw pictures of each. Use your pictures to construct a bulletin board.
3. Animals are affected by seasonal changes.	. Identify animals which migrate, hibernate, change color, or grow heavier coats as the seasons change.	. Place a frog in a container of water to which some ice is gradually added and observe what happens. Take the frog out and gradually warm him. Observe what happens.
4. Each living organism is directly or indirectly dependent upon green plants.	. Discover that every green plant makes food. Every animal captures food from the environment. If the environment changes, the plant or animal may become extinct.	. Use the bulletin board to develop a simple food chain. Remove all green plants from the food chain. Discuss the results.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
B. Plants		
1. Green plants are living organisms that make their own food.	. Understand that a green plant needs carbon dioxide from the air, water from the soil, and energy from the sun to make its food.	. Use two green potted plants. Put plants near a window and make sure each gets the same amount of water and light. After a few days cover one of the plants. Keep watering both plants. After a week remove the cover and view the results.
2. Food made by plants is stored in different parts of the plant.	. Classify plants according to where food is stored.	. View a film to show this concept. After viewing the film, have children make a collection of plants that store food in various parts (leaves, roots, stems).
3. Nongreen plants have many uses.	. Understand the uses of yeast mold and mushrooms.	. Make a field trip to observe mushrooms and other nongreen plants. . Bring a piece of blue or Roquefort cheese to class. Allow children to examine the cheese with a magnifying lens. Allow children to smell and taste the cheese.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Examine a cake of yeast. Put one-half cup of warm water, one-fourth package of yeast, and one tablespoonful of sugar in a beaker. Stir mixture. Let stand for twenty minutes. Examine under a microscope. Discuss how yeast is used in baking.
II. EARTH SCIENCE A. The Sun and Solar System		
1. The sun is the center of the solar system.	. Recognize the names, planets, and words related to the solar system and space.	. Examine a model of the solar system. Encourage children to locate the planets. Investigate Galileo's discovery of the telescope. . Observe the sky. Discuss the planets that are seen.
2. The planets travel in orbits about the sun.	. Illustrate the orbits of the nine planets about the sun.	. Use modeling clay and wire to construct a model of the solar system.
3. Rotation of the earth causes day and night.	. Demonstrate the causes of day and night.	. Use a flashlight or other light source, globe, and picture of a child. Make the light stationary.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Fix the picture at some point on the globe. Rotate globe. As picture moves, discuss causes of day and night.
4. The tilt of the earth's axis and its revolution about the sun cause the seasons.	. Show how the earth's axis and orbit are related to seasonal changes and climate.	. Use a globe to demonstrate the earth's movement and seasonal changes.
5. The moon revolves around the earth every 29 1/3 days.	. Become aware of the movements and phases of the moon.	. Have children observe and draw pictures of the moon one night each week for four weeks. Display and discuss drawings.
B. The Earth		
1. Changes in the earth started millions of years ago.	. Learn that changes in the earth's surface are caused by wind, water, volcanoes, etc.	. Make observations of physical weathering. Discuss causes of these changes.
2. The solid earth is composed of three main parts: the crust, mantle, and core.	. Develop an understanding of the composition of the earth.	. Compare a slice of apple or watermelon to the earth's structure. Discuss the idea that these fruits are structured in layers. They both have outer skins, a pulpy layer, and a core. Relate this to the earth's structure.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. From research make a model of the earth. Color and label the crust, mantle, and core.
C. Rocks and Soil		
1. Rocks have identifiable properties.	. Be able to group rocks as to weight, color, smoothness, hardness, or formation.	. Take a field trip or nature walk to collect rocks which illustrate a variety of properties.
2. Rocks are formed through the forces that wear down and build up the earth's surface.	. Demonstrate that heat, cold, running water, wind, plants, and man help to break rocks into pieces.	. Plant some soaked bean seeds just under the surface of the soil and pour about one-quarter inch of plaster of paris on top of the soil. As the seeds germinate, the children should observe that the seeds force their way through the plaster, causing it to crack.
3. Soil is composed of rock particles mixed with decayed plant and animal matter.	. Identify particles found in a sample of soil.	. Collect rocks. Rub them together. Observe the wearing away of the rocks. . Examine several samples of soil. Discuss composition of each sample.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. Soil is one of our greatest resources and should be conserved.	. Understand the uses of soil.	. Make observation of the neighborhood. Discuss the wise uses of soil.
III. PHYSICAL SCIENCES		
A. Machines and Their Uses		
1. Machines are used to do work.	. Identify machines that help us do work.	. Discuss work that is done in the environment. Identify machines that are used to do various jobs. Have children lift a pile of books in a wheel barrow or small wagon. Note how easy the task becomes with the use of a machine.
2. There are many types of simple machines.	. Identify simple machines, such as levers, pulleys, wedges, screws, inclined planes, wheels, and axles.	. Construct a bulletin board of simple machines.
3. Complex machines are combinations of two or more simple machines.	. Identify simple machines that make up common complex machines.	. Identify household and outdoor tools that are simple machines. . Examine a bicycle carefully and note the many simple machines that make up the complex machine.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. Whenever two things rub against each other, there is friction.	. Discover that friction makes work more difficult and also produces heat.	. Have children rub their hands together and observe the production of heat. . Have children rub sandpaper on a block of wood and notice the production of heat.
5. Friction can be reduced by lubrication.	. Show that lubrication will reduce friction.	. Have children examine a bicycle or other machine that needs lubricating. Lubricate the machine. Children should be able to detect a reduction of friction.
B. Matter and Energy		
1. Matter takes up space and has weight.	. Discover that all matter takes up space and has weight.	. Weigh a tire or balloon. Fill with air. Weigh again. Note differences in size and weight.
2. Matter may exist in any one of four states: solids, liquids, gases, or plasma.	. Be able to identify solids, liquids, or gases in the environment.	. Make a bulletin board of various pictures and have students identify states of matter.
3. A physical change is a change in the size, shape, or state of matter.	. Be able to determine that a change of state or appearance is a physical change.	. Use puzzles showing various states of matter.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Let the children work with clay in demonstrating physical changes. Clay is easily worked, separated, and combined.
4. Heat causes matter to change.	. Show that heat will cause matter to dissolve, melt, or evaporate.	. Perform an experiment using heat to melt ice and then observe the evaporation.
5. Chemical changes occur when a new substance is formed.	. Understand simple chemical changes.	. Burn paper or make cookies. Have children compare substances before and after experiments.
C. Sound		
1. Sound is a form of energy produced by vibrating matter.	. Identify and classify different ways of producing sounds.	. Have the children observe the vibrations of a rubber band, a ruler, or a tuning fork. . Strike a toy drum with a few tiny pebbles on it. As one strikes the drum, watch what happens to the objects.
2. Sounds can be loud or soft, high or low.	. Demonstrate that a loud sound has more mechanical energy than a soft sound and causes the eardrum to vibrate through	. Blow a whistle very gently, then vigorously. The first sound is soft; the second is the same pitch as the first,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	a greater distance than a soft sound.	but the sound is louder.
3. Sound travels through all forms of matter.	. Determine what forms of matter transmit sound best. (Best through solids, next best through liquids, and least best through gas.)	. Let the children listen to the ticking of a wristwatch that is lying on a table, held at one end of a meterstick and one end of an iron bar. Sound will travel best through the iron bar and least through the air.

FOURTH GRADE

I. LIFE SCIENCE

- A. Characteristics of Living Things
- B. Plant and Animal Groups
- C. Interrelation of Plants and Animals
- D. Use of Plants and Animals
- E. The Senses
- F. Famous Scientists

II. PHYSICAL SCIENCE

- A. Production, Use, and Conservation of Energy
    - 1. Electricity
    - 2. Magnetism
    - 3. Light
    - 4. Heat
- B. The Six Basic Machines
- C. Famous Scientists

III. EARTH SCIENCE

- A. Weather
    - 1. Instruments
    - 2. How weather affects man
    - 3. Kinds of precipitation
- B. Famous Scientists
- C. Land and Its Resources
- D. Space
    - 1. Aviation
    - 2. Principles of flight
    - 3. History

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. LIFE SCIENCE		
A. Characteristics of Living Things		
Living things have at least five characteristics in common.	. Observe that living things grow, have movement, reproduce, react, and utilize food.	. Have one or more living organisms available for the students to observe and care for.
B. Plant and Animal Groups		
Plants and animals are grouped according to their characteristics.	. Know the reason why plants and animals are placed in their respective groups.	. Divide the class into five groups to do research. The groups will list the characteristics of Fish, Amphibians, Reptiles, Birds, and Mammals. Ask groups to make a chart of the characteristics they find.
	. Identify various plants and animals by use of pictures and live or preserved specimens.	. Make a field trip to a zoo, nursery, or pet shop.
C. Interrelation of Plants and Animals		
Plants and animals are dependent upon each other.	. Understand how plants and animals depend upon each other.	. Display pictures of animals that are becoming extinct. Give

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		reason why these animals are becoming extinct.
D. Use of Plants and Animals Some animals are more beneficial to man than others.	. Explain some of the uses man makes of animals.	. Make a field trip to observe the animals and their food supply in your neighborhood. . Set up a balanced terrarium or aquarium. . Make a chart showing insects that are harmful and helpful to man. . Make a bulletin board showing animals that are useful for food, clothing, hunting, working, and medicine.
E. The Senses The senses are used to understand the environment and protect the individual from external forces.	. Understand the protection devices of the body, their structure, and their function.	. View films, filmstrips, and/or models on structure and function of the senses. . Invite a doctor or nurse to talk

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		to the class about the care of the sense organs. . Play the blindfold game to identify familiar objects by using other senses.
F. Famous Scientists There have been many contributions of famous men in the field of life science.	. Understand and appreciate what men have done in the field of life science and how it has helped us.	. Make reports on these men and find out how they have helped man: Anton Leeuwenhoek Robert Hooke Carolus Linnaeus Luther Burbank Alexander Fleming
II. Physical Science A. Production, Use, and Conservation of Energy 1. There are different forms of electricity.	. Demonstrate how you can make different forms of electricity.	. Rub a fountain pen on a piece of nylon and pick up a piece of paper with the pen.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Rub two balloons on nylon and observe how they repel each other.
2. Electrical energy may be changed to heat and light energy.	. Follow an energy conversion system.	. Use hot plate to show the change of electrical energy to heat energy.
		. Use a light bulb to show the change of electrical energy to light energy.
3. Magnets are used in various ways.	. Demonstrate that magnets are used to make compasses.	. Rub a needle 40 times in the same direction on a magnet. Suspend the needle on a string. It will stop movement pointing north and south.
	. Demonstrate that magnets are used in radios, televisions, and telephones.	. Take an old radio apart and find the magnets.
4. Light is a form of energy that shows characteristics of both waves and particles.	. Demonstrate that white light can be reflected to show colors of the spectrum.	. Use a prism to catch a ray of sunlight and observe the rainbow colors that focus on a piece of paper and list the order of the colors.
5. Heat causes molecules to move more rapidly.	. Understand that rapidly moving molecules have a higher	. Compare the temperature of ice water with that of rapidly boiling water.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	temperature than slowly moving molecules.	. Place a dish of vinegar on a table. Ask pupils to identify the liquid from their desk. Heat the vinegar. As children identify the liquid through the sense of smell, conclude that the heat caused the vinegar molecules to spread rapidly.
B. Machines Machines make work easier.	. Identify and use the six basic machines.	. Make and/or use transparencies to show how each of these machines make work easier. . Observe complex machines. List the simple machines that can be seen in their construction.
C. Famous Scientists Many men have contributed to the field of physical science.	. Understand and appreciate what men have done in the field of physical science.	. Make reports on these men and find out what they have contributed to the field of science: Michael Faraday Archimedes Thomas Edison Albert A. Michelson

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Albert Einstein Archie Carr Ben Franklin
III. EARTH SCIENCE A. Weather 1. Weather information is collected with many kinds of instruments.	. Construct simple weather instruments and develop an appreciation for persons who work with weather forecasting.	. Students will construct hygrometer in this manner. a. Cut one side from a paper milk carton. b. Place some clay in the middle of the carton. c. Push a flat toothpick into the clay. (The clay is to be high enough for the toothpick to stick above the sides of the carton.) d. Stretch a human hair lengthwise across the milk carton; attach the ends of the hair with tape. e. Mark the toothpick with a felt-tip pen where the hair crosses it.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Students should listen to the radio or TV for reports on humidity and observe the reaction of the hair to humidity. . Make a weather vane.
2. Weather may have helpful or harmful effects on man.	. Discuss what weather conditions mean to the farmer and other people for whom he provides.	. Research and explain what effects the weather has on agriculture, transportation, clothing, and homes. . Tell how frost, hail, rain, and drought affect the farmer and the people for whom he provides.
3. An atmosphere filled with pollution can prevent warming sunlight from reaching the earth and can eventually change the climate.	. Learn ways to prevent pollution.	. Have resource people speak on pollution. . Make charts listing kinds of pollution and means by which pollution can be prevented.
4. There are many forms of precipitation.	. Learn the different kinds of precipitation--rain, sleet, hail, and snow--and what causes each.	. Show filmstrips on the different forms of precipitation. . Make a collage of various forms of precipitation.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
5. Wind is air in motion caused by uneven heating of the surface of the earth by the sun.	. Understand that variation in air temperature causes air to move.	. Make an air tester. Flatten a drinking straw one inch at the end. Tape a piece of paper 3" wide and 4" long to it. Push a pin through the middle of the straw and into the eraser of a pencil. Wiggle the straw so that it can turn easily around the pin. Flatten the other end of the straw. Slide a paper clip over the end of the straw. Pick up the pencil to see if the straw hangs level. If not, slide the paper clip back and forth until it is level. Hold the tester over a warm place (light bulb, heater, sunny windowsill). Take the temperature at the various places the tester was used. The warmer air will cause the tester to rise.
B. Famous Scientists Men have contributed much to the study of weather.	. Understand and appreciate the contributions of men in the field of weather.	. Make reports on these men and find out what they contributed to science: Nicolaus Copernicus

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Galileo Galilei Isaac Newton Anders Celsius Daniel Bernoulli
C. Land and Its Resources		
1. The surface of the earth is made of many different kinds of rocks.	. The student will discover what rocks can tell about the earth.	. Collect rocks and display them.
	. Learn the difference in the formation of the three major groups of rocks.	. Make a study on the work of a geologist and find what this field has to offer as a career.
		. Research the three major groups of rocks: (1) igneous (granite); (2) sedimentary (sandstone); (3) metamorphic (marble). Make charts and put pictures of rocks in each group.
		. Collect samples of the various types of soil. Bring these samples to class and examine the composition of each.
2. Water covers a large portion of the surface of the earth.	. Compare the ratio of water to land on surface of earth.	. Construct a model (globe) showing the water and land areas of the world.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. Plants and animals depend directly or indirectly upon the soil. It is one of our basic renewable resources.	. Learn that plants and animals depend upon the soil for existence.	. Have resource persons talk to the group on soil and conservation of soil. . Make poster listing habitats of animals and show how these are dependent upon soil. . List ways in which the environment has been altered.
4. The earth is constructed in layers.	. Name the layers of the earth's interior.	. Vist a place where the highway cuts through a hill to observe the layers of soil and various rock formations. . Make a drawing of a cross section of the earth showing the crust, mantle, and core. . Have a geologist visit the classroom and show samples of soil and different rock formations.
5. The surface of the earth is constantly changing.	. Establish an understanding of the processes of change which affect the surface of the earth and how this change is brought about.	. Classify mountains according to manner of formation, folded, volcanic, fault.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. Learn the major agents of erosion and how they work.	. Construct a volcano. . Observe areas of erosion in the community. . Have student collect pictures that illustrate wind and water erosion.
D. Space		
1. Aviation plays an important part in the space program.	. Discuss the importance of aviation in relation to the space program. . Learn what careers are offered in the space program.	. Make a class booklet on the history of aviation. . Collect pictures of various forms of aircraft and make bulletin board. . Show filmstrips on space travel. . Do research on careers in aviation and in the space program.
2. For every action there is an opposite and equal reaction.	. Explain how a jet plane or a rocket takes off.	. Blow up a balloon and attach it to a string that has been placed across the room. The balloon will be attached by tape and a piece of paper so that it can glide along the

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		string. Let the balloon go, allowing the air to escape as it goes.
3. Drag and gravity have to be overcome by lift and thrust for flight.	. Explain the interactions of these four forces in the process of flight.	. Observe the flight of birds. . Show filmstrip on the principles of flight. . Make model airplanes or bring model airplanes from home to illustrate the principles of flight.
4. Much work has gone into perfecting modern-day flying.	. Know and appreciate the efforts of pioneer experimenters in aviation.	. Make a mural on flight depicting the history of the present day. . Show films and filmstrips on Wright Brothers and Robert H. Goddard.

FIFTH GRADE

I. LIFE SCIENCE

A. Plants and Animals
  1. Cellular structure of plants and animals
  2. Classification of plants and animals
  3. Endangered species of plants and animals

B. Food for Growth and Maintenance

II. PHYSICAL SCIENCE

A. Matter and Energy
  1. States of matter
  2. Structure of matter
  3. Elements, compounds, and mixtures
  4. Physical and chemical changes in matter

B. Sound and Energy
  1. Production of sound
  2. Characteristics of sound
  3. Uses of sound energy
  4. The function and care of the ears

III. EARTH SCIENCES

A. Weather and Oceanography
  1. Weather--causes, effects, and control
  2. Oceanography

B. Land and Its Resources

C. Space
  1. The solar system
  2. Exploration

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. LIFE SCIENCE		
A. Plants and Animals		
1. All plants and animals are composed of cells.	. Recognize the differences in plant and animal cells; recognize various kinds of tissue cells--nerve, epidermal, etc.--as seen under a microscope.	. Place a drop of pond water or water where microscopic organisms exist under the microscope. Make drawings of what is seen under the microscope. . Observe leaves from various plants under the microscope. Make drawings of microscopic view. . Observe a piece of onion skin to identify the cells. Cut the onion lengthwise, remove a thick layer, and peel off a small sample of the thin membrane from the inside of the layer. Mount the sample in a drop of water on a slide and cover with a cover glass. Study the cells under the microscope. Then lift the cover glass and add a drop of iodine solution to stain the cells, cover, and study again. One should be able to see the parts of the cells more clearly.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Use a flat toothpick to secure a sample of epidermal cells from the cheek. Observe under the microscope. . Use prepared slides of nerve and muscle cells to observe differences and similarities between these two types of cells.
2. Cells group together to form tissues, organs, and systems.	. Understand the function of tissues, organs, and systems.	. In individual or group activities make a list of organs and systems. After each organ listed, give its function. After each system listed, give the organs that make up that system. Example: Organs: Heart--pumps blood to all parts of the body. Systems: Digestive--teeth, tongue, esophagus, stomach, small intestine, and large intestine.
3. Scientists classify plants and animals for identification and description.	. Group plants into one of the four phyla.	. Prepare a display with the four phyla labeled--Thallophyta, Bryophyta, Pteridophyta, Spermatophyta. Have a description of each phyla under label. Bring examples of plants to school and place them under the correct phyla.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. Group animals into groups of vertebrates and invertebrates.	. Prepare bulletin board on vertebrates and invertebrates.
4. Some plants and animals are in danger of becoming extinct.	. Observe that man's uses of plants and animals have caused some plants and animals to become endangered and others extinct.	. Collect articles and pictures of plants and animals that are becoming endangered. Find reasons why they are; tell how they can be protected. Use reference books, audiovisual material, radio and T.V. reports, and information from environmental groups to help you.
B. Food for Growth and Maintenance		
1. All living things must have food to survive.	. Understand that one great difference between plants and animals is the way they acquire food.	. View a film or filmstrip that explains photosynthesis. Make an illustration to show how plants make food. . Collect pictures of various animals. Discuss how each animal secures food.
2. Daily food requirement charts help us to choose our food wisely.	. Examine a Food Guide to understand what is included in a balanced diet.	. Keep a daily record of meals served in the lunchroom for a period of one week. Check the record with the Food Guide to see if the meals are balanced.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. Choose foods that will constitute a balanced diet and correctly fit sweets and candy into a well-balanced diet.	. Write a menu for your favorite meals. Check it with the Food Guide to see if the meal is balanced. . Dramatize scenes which show: (a) proper times for eating sweets (b) how a person might eat "plenty" of food and not be healthy.
3. The digestive system changes food into a form so that the body can use it for growth and maintenance.	. Understand that digestion begins in the mouth and ends in the small intestines. . Explain that muscular contractions and not gravity cause food to move through the intestines.	. Make a model or diagram of the digestive system to show how food is digested.
4. Chemicals produced by the digestive system aid in the digestion of the food we eat.	. Discuss the process of digestion and the effects of enzymes on the food we eat.	. Place a piece of lean meat in hydrochloric acid (chlorox or vinegar may be substituted). Observe what happens. This illustrates the effects of enzymes on the food we eat.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
II. PHYSICAL SCIENCE		
A. Matter and Energy		
1. Matter exists in four states--solids, liquids, gases, and plasma.	. Identify substances that represent solids, liquids, and gases.	. Boil water to show the liquid and gaseous states of matter. Use ice and other solids to illustrate the solid state of matter.
2. Matter is composed of small particles called molecules which, in turn, are composed of small particles called atoms.	. Explain how odors are detected by molecular movement.	. Open a bottle of vinegar or perfume. Explain why odor can be detected at a distance.
	. Illustrate the structure of a molecule of water (H_2O).	. Use colored beads, balls, or blocks to construct a molecule of water.
		. View a film to understand molecules and atoms. Use other audiovisual material to understand molecules and atoms.
3. An element is composed of atoms of one kind.	. Know the symbols for several of the common elements.	. Display several elements (iron, sulphur, mercury, etc.).
4. A physical change in matter is a change from one form to another without any change in chemical structure.	. Illustrate and understand a physical change.	. Cut a sheet of paper into several pieces. Observe that the paper can be put together again. Each smaller piece of paper is the same material as the sheet of paper before it was cut.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Dissolve some salt in water. Note what happens. Note what happens when the water evaporates.
5. Chemical change is the result of changes in the composition of matter.	. Observe a chemical change.	. Burn a piece of paper. Compare it to the sheet of paper that was cut up in activity above. . Note changes in environment. Classify them as physical or chemical.
B. Sound and Energy		
1. Sound is caused from vibrations.	. Explain how sound is produced.	. Have a cigar box with different length rubber bands stretched around it. As rubber bands are plucked, listen to and watch for the frequency of the vibration. . Use pop bottles with varying amounts of water in them. Blow across them and place them according to pitch from high to low. . Let children bring musical instruments and explain how they produce sound.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Sounds made by the human voice are an overlaid function.	. Explain two functions of the lungs, larynx, lips, tongue, and teeth.	. List on a chart the organs of speech. After each organ listed, indicate the part it plays in speech production and its primary function.
3. The ear is the organ that catches sound waves. The brain interprets the sounds we hear.	. Describe the parts of the ear and their function in hearing.	. Draw a diagram of the ear. Label the main parts. Show how the auditory nerve goes to the brain for interpretation of sound. . Use a model of the ear to explain how we hear. . View a film which explains the function and/or care of the ear.
4. Exposure to loud sounds over a long period of time can cause permanent hearing loss.	. Have an appreciation of the sense of hearing. . Explain ways of protecting the sense of hearing.	. Interview a person who works in a high-level noise situation. Ask about the precautions that are taken to prevent hearing loss.
III. EARTH SCIENCE		
A. Weather and Oceanography		
1. Weather is caused by the	. Describe some ways heat energy,	. Keep a daily record of weather data.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
interaction of air, water, and heat.	water movement, and air movement affect weather.	. Make a convection current box showing how the heat interacting with the air causes it to circulate.
		. Make it rain by boiling water on a hot plate. Hold a metal cup filled with ice above the boiling water. Condensation from the water will get heavy enough to drop off the cup showing the interaction of air, water, and heat.
2. Weather affects our lives in many ways.	. Explain how weather has regulated or affected plans for recreational activities or travel.	. Write a paragraph explaining how weather has caused a change in some activity.
	. Understand why airports have weather stations.	. Visit a weather station or airport to gather information on the importance of weather reports to pilots.
	. Relate how weather determines the price of food.	. Keep a scrapbook of newspaper reports which give weather information from around the country. After harvest season check the prices of various fruits and vegetables. Note how weather

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		might have caused a difference in prices.
	. Understand the devastating results in lives and property caused from hurricanes.	. From reference books and audio-visual materials, prepare a report on the effects of devastating hurricanes.
3. Scientists are working on ways to control weather.	. Explain how rainmaking chemicals are used.	. Use reference books and audio-visual materials to study the history of rainmaking from early incantations to present-day methods.
	. Understand why a change in an ocean current would affect weather.	. On a map plot the Gulf Stream. Suppose the Gulf Stream changed its course. Plot it as it might be, showing how other parts of the world might be affected by the new course.
	. Relate how forecasts save lives and property in pre-warnings of tornadoes, hurricanes, floods, and freezes.	. Role play media warnings of tornadoes, hurricanes, flash floods, and freezes. Include the preparations that people might make as a result of listening to your report. Depict the after-events of such disasters had there been no warning and show the results after warning.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. Explain how arid areas are made habitable.	. Draw a diagram showing how an irrigation system works.
4. Heat inversions sometimes occur as a result of pollutants in the air.	. Discuss reasons for heat inversions and steps that can be taken to lessen the possibility of such occurrences.	. Write the weather bureau for information on the pollution content of the air. Make a bar graph showing the various percentages.
5. The ocean is all the water that fills the great basins which surround continents.	. Know that the ocean covers about three-fourths of the earth's surface.	. On a globe or map compare the amount of water in proportion to the amount of land. . On a map or globe locate ten bodies of water that are extensions of the oceans.
6. Life in the ocean is affected by many variables.	. Explain how salinity, temperature, depth, and light affect the amount and kind of life in the ocean.	. Prepare reports on the depth and kind of life in various parts of the ocean.
7. The ocean floor reveals many geological formations.	. Explain that the ocean itself is one vast body of water. Be aware that along the edges of the continents are broad underwater plains called Continental Shelves. Know that the Mid-Oceanic ridges give support to the Continental Drift Theory.	. Study a map or globe showing the Continental Shelf and deep places . View films which show geological information on the ocean floor. . Use plaster of paris and construct an ocean floor. Prepare

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		a report to explain the geological formations found on the ocean floor. . Research work on examining the volcanic and earthquake activity that measurements have shown are pulling the continents further apart.
8. Many people depend upon the ocean for their livelihood.	. Understand the importance of the ocean in the life of man.	. Use reference books and audio-visual material to make a chart on "Uses of the Sea." . Make a list of products that come from the sea.
9. Special types of equipment are necessary for underwater exploration.	. Discuss and illustrate how water pressure affects the design and construction of equipment for underwater exploration.	. Have a scuba diver come to class and explain the proper uses of such equipment. . Collect pictures and prepare reports on the use of the bathyscaph and bathysphere in deep sea exploration. . Investigate the life and work of Jacques Piccard and Jacques Cousteau.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Write the Environmental Services for information on control devices to lessen pollution.
B. Land and Its Resources		
1. Through scientific research the earth appears to be very old.	. Explain and evaluate several of the theories advanced about the origin of the earth.	. (a) On a chart list several theories about the birth of the earth. After each theory list evidences which support the validity of the theory. In a separate column indicate what each theory does not explain. . (b) Make a show-and-tell from a cardboard box. Use pictures which are representative of the various theories. Paste pictures on paper and fasten to dowell stick inside cardboard box. Show as a moving picture or T.V.
	. Know some of the tests used in calculating the age of the earth and its fossils.	. Use reference books to find out about the Uranium and Carbon-14 dating methods.
2. Fossil evidence seems to indicate that life	. Identify trilobite and nautiloid fossils and recognize a	. Make a fossil by using clay on plaster of paris. Place a

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
has been on earth for several billion years.	piece of graphite.	one-half inch layer of modeling clay in a box lid. Press several shells into the clay to make an imprint. Spread a thin film of petroleum jelly over the clay. Fill the box lid with a thin mixture of plaster of paris. After the plaster of paris hardens, remove it. Compare the original shells with the imprint and mold. . Visit a chert or slate pit and dig for fossils. . Invite a member of the Geological Services to visit the class and discuss his work. . Write with a piece of graphite.
3. Scientists have measured the earth's history in geological periods based on the predominance of fossil remains in the layers of rock and land formations.	. Know the three main divisions of fossils producing geological time and the reason for their division--Cenozoic, Mesozoic, Paleozoic eras.	. View a film or other audio-visual material which shows how different layers of rock reveal a predominance of certain forms of life. . Make a Geological Time-Life Chart. Indicate the life, climate, and land features of each geological period.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. Some scientists believe that the land formations were, at one time, one big land mass.	. Explain the reasons scientists believe that all land on earth was at one time one big land mass.	. Look at a map and observe how the continents seem to fit like a jigsaw puzzle. . Use reference books for information concerning this theory. Divide into two debate teams; give evidence to support or refute this theory. . Make field trip around the school or community for fossils.
5. The minerals of the earth are being used up at a faster rate than they are being formed.	. Explain why some minerals are in short supply and why it is necessary that their production be increased or their consumption be reduced. Decide which is more feasible.	. Write to the Department of Interior for information on how minerals are being conserved. . Have a member of an oil company come to the classroom and discuss the use and production of oil. . Compare mineral usage in the early days of the country's history with mineral usage today. . Have a member of a strip mining company come and speak to the class about strip mining.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Space		
1. The solar system is composed of sun, the planets, their satellites, meteors, and comets.	. Understand that the sun is the center of the solar system. The planets revolve and rotate in orbits about the sun.	. View a film on the solar system to learn the size and order of the planets in the solar system. . Make a model of the solar system by using little balls of clay to represent the planets.
2. It took many scientists over a long period of time for the present generation to have the knowledge of space that it now has.	. Gain an appreciation for the patience and work of pioneers in astronomy. . Recognize how one discovery led to another.	. Use reference materials and list the contributions each scientist made to the study of astronomy: Tycho Brahe, Johannes Kepler, Isaac Newton, Galileo.
3. Distance between objects in the solar system reach millions and even billions of miles.	. Determine the distance light travels in a light-year.	. Distances beyond the solar system are measured in units of light-years. A light-year is the distance light travels in one year. Figure out how far light travels in one year. (Note: Light travels 186,000 miles per second.)
4. The moon is the earth's nearest neighbor in space.	. Determine how far the moon is from the earth.	. Find out how far the moon is from the earth. (221,000 miles its perigee--235,000 miles its apogee.) Make an illustration showing the distance between the moon and the earth.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
5. Changes that seem to appear in the moon are called phases.	. Explain the phases of the moon.	. Use reference books, films, and filmstrips to learn about the phases of the moon. Make a classroom display on the phases of the moon.
6. The gravitational pull of the sun and moon affects the surface of the earth as evidenced in the tides.	. Explain how the phases of the moon and neap and spring tides are related.	. Use models of the moon and earth and sun. Explain how rotation of the earth relates to high and low tides each day. Explain how the new and full moon phases cause increased gravitational pull resulting in spring tides twice a month. Explain how the quarter phases cause less gravitational pull resulting in neap tides.
7. Many forces shaped the surface of the moon.	. Explain how volcanic activity, gravity, and meteors have acted on the surface of the moon.	. Examine photographs of the moon's surface. Note the craters, cracks in the plains, and mountains. Try to determine which force might have caused the surface to appear as it does today.
8. Telescopes are used to study space.	. Explain the difference between a refractor and a reflector telescope.	. Use reference books, films, and filmstrips to find out how the refractor and reflector telescopes work.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
9. There are many problems in space travel.	. Understand the problems associated with acceleration, weightlessness, radiation, deceleration, and distance in space travel.	. Have a person who works with the space program come to the classroom and talk to the class about space exploration. . Prepare reports on the problems associated with space flight; tell how scientists are solving these problems.
10. Space explorations have produced many products that are being used to improve life on earth.	. Discuss the benefits of space explorations.	. Find out how artificial satellites have improved communications and weather forecasting. . Have a doctor or someone who wears a pacemaker to come to the classroom and talk to the class about the function of the pacemaker. . Make a display of foods that have been developed as an outgrowth of the space program.

SIXTH GRADE

I. LIFE SCIENCE

A. Basic Structure of Life
B. Communities and Habitats of Plants and Animals
C. Reproduction of Plants and Animals
D. Uses of Plants and Animals
E. The Human Body
  1. The skeletal system
  2. The muscular system

II. PHYSICAL SCIENCE

A. Matter
  1. Make-up
  2. Changes
  3. Properties
B. Energy
  1. Production
  2. Consumption
  3. Conservation
C. Famous Scientists

III. EARTH SCIENCE

A. The Atmosphere
B. The Hydrosphere
C. Weather
  1. Cloud formation
  2. Air masses
  3. Map reading
D. Space
  1. Exploration
  2. Programs
E. Effects of Space Research
F. Famous Scientists

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. LIFE SCIENCE		
A. Basic Structure of Life		
1. The structure of all living things is the cell.	. Explain that cells carry on the functions of life.	. Make an illustration of a one-celled organism and a multi-celled organism; list the similarities and differences. Use reference books and audio-visual materials to secure information. . Make typical animal and plant cells out of cloth or playdough.
2. All cells come from cells.	. Understand that through cell reproduction species survive and reflect the characteristics of the parents.	. Use audiovisual materials to show cell division and reproduction. . From a growing onion, peel off a thin layer of tissue from the tip of the root. Place this tissue in a drop of water on a glass slide. Now add a small drop of iodine to the drop of water and cover the tissue with a cover slip. Observe the tissue carefully through a microscope. Note cells that are dividing. Draw pictures of what you see.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Mix one-fourth package of yeast, one tablespoon of sugar, and one-half cup of warm water. Let stand for twenty minutes. Place a drop of the mixture on a slide and observe under a microscope. Note division of cells. . Show slides of cell division. . Display pictures of off-spring and parents that resemble each other. . Display pictures of off-spring that do not resemble the parents. Show the development illustrating the effects of heredity. . Invite a cattle or dog breeder to talk to the class.
3. Changes in the genetic code result in changes in living things.	. Understand how concepts of heredity are applied in improving strains of plants and animals.	. Study the work of Gregor Mendel and Luther Burbank. Make an illustration or chart to show the important aspects of your findings.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
B. Communities and Habitats of Plants and Animals		
1. Living things depend basically on the capture of radiant energy by green plants.	. Understand that living things are interdependent with their environment and that man must conserve the world ecosystems within which he lives.	. Prepare a bulletin board display showing various food chains and food webs. Discuss the interdependence of organisms in the food chains and webs. . Display news articles on pollution. List ways pollution might be prevented and controlled.
2. Living things are adapted by structure and function to their environment.	. Explain how the structure of living things enables adaptation to the environment.	. Make a chart or booklet of various organisms and list ways they are adapted to live in their environment.
C. Reproduction of Plants and Animals		
1. Differentiation and organization cause cells to become grouped into particular parts of an organism with particular functions.	. Know the specific functions of the parts of plants.	. Observe a plant. Make an illustration of the plant. Use reference books and audiovisual materials to determine the function of: (a) leaves (b) stems (c) roots

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Flowering plants produce seeds.	. Identify the parts and function of a flower.	. Bring flowers to school to analyze and study. . On a drawing label the parts of a typical flower. Discuss the function of each part: anther petal stigma ovary pistil sepal stamen . Observe bees as they visit flowers. Determine why they visit flowers. Note how they help in pollination.
3. Scientists have grouped living things according to characteristics.	. Recognize similarities and differences among living things which aid scientists in organizing and grouping organisms.	. On an activity sheet list the characteristics of each group. Draw or collect pictures of animals or plants and arrange them in the appropriate group.
D. Uses of Plants and Animals		
1. Man uses plants and animals for food, medicine, clothing, materials, and work.	. Explain how man makes use of plants and animals.	. Make a display of the uses man makes of plants and animals.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Use and conservation of plants and animals provide a variety of careers for man.	. Become aware of the many careers available through the care and utilization of plants and animals.	. Use audiovisual material resource persons and research to learn about careers related to plants and animals.
E. The Human Body		
1. The body is supported by the skeletal system.	. Learn the major bones of the skeleton.	. Study and label bones of the skull, arms, shoulder, backbone, and legs. . Collect bones of various animals and identify the various parts of the bones.
2. The bones are tied together at the joints.	. Explain how the bones are held together at the joints, providing for movement.	. Use uncooked leg and thigh or wing of chicken to show how joints, ligaments, and cartilage help in holding the skeleton together. . Observe the various ways the body can move. Locate and name various joints that cause movement (pivot, ball and socket, and hinge).
3. Movements of the skeleton are brought about by the contraction and relaxation of the skeletal	. Understand how the muscles and bones work together to cause movement.	. Use arm to illustrate opposing muscles--biceps and triceps.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
muscles.		. Illustrate the effects of the muscle and skeletal systems on posture.
4. Bones may be injured by diseases.	. Learn the effects of rickets on the skeletal system.	. Use reference books and audio-visual materials to find the causes and prevention of rickets.
5. Although teeth are not parts of the skeleton, they are largely composed of hard, bonelike material.	. Learn the parts, care, and function of the teeth.	. Use modeling clay to make a tooth. Label each part. . Make a chart of the function and care of the teeth. . Invite a dentist or nurse to come and talk to the class about the teeth and their care.
II. PHYSICAL SCIENCE		
A. Matter		
1. Matter is any substance that has weight or mass.	. Explain what matter is.	. Discuss several items in the classroom. Tell why they are classified as matter.
2. Matter exists in one of four states: solids,	. Classify solids, liquids, and gases.	. Bring a collection of solids, liquids, and gases to the

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
liquids, gases, and plasma.		classroom. Discuss properties of each state of matter. Classify the collection.
3. There are general properties of matter that can be used to describe all forms of matter.	. Explain the common properties of matter: inertia, mass, weight, density, porosity, volume.	. Observe the porosity of matter by filling a beaker with sand. Add water slowly. Explain why water can be added to the beaker.
4. There are special properties of matter.	. Identify some of the special properties of matter: brittleness, color, elasticity, odor, etc.	. From a collection of items on a table, group each item according to a property.
5. The molecular theory states that all matter is composed of small particles.	. Understand that the particles that make up matter are atoms and molecules.	. Use audiovisual materials to illustrate molecular structure. . Draw on the board a finger tip. Explain that if each of the molecules in it were as large as a grain of sand, the finger tip would be one mile wide and one mile high.
6. The atom consists of fundamental particles.	. Learn the particles of the atom--electron, proton, and neutron.	. Use reference books and audiovisual materials to make a chart to show the charge that each particle carries.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
7. The atoms of radioactive elements give off rays and particles.	. Learn the three kinds of rays that radioactive elements give off--Alpha, Beta, Gamma.	. Use reference books and audio-visual materials to find out about X-ray. . Use reference material to find out how the Geiger Counter is used. . Make a chart to show the penetrating ability of each ray and particle. Explain why fallout shelters must be several centimeters thick. . Invite a person from Civil Defense to discuss specifications for constructing fallout shelters.
8. Because the different kinds of atoms can combine in so many different ways to form molecules, the number of different kinds of molecules is great.	. Explain that a substance composed entirely of atoms of one kind is called an element. . A substance that is composed of two or more different kinds of atoms combined in a definite proportion is a compound.	. From a collection of elements--iron, mercury, etc.--and compounds--water, salt, etc.--group the items under the headings. Elements / Compounds Mercury / Water

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
9. Solutions are a special class of mixtures.	. Understand that a solution is a special class of mixture.	
10. Matter is capable of change.	. Explain and identify chemical, physical, and nuclear changes.	. Change several pieces of matter into different forms. Tear paper; put it back together. Break chalk. Melt ice. Dissolve sugar in water. Boil sugar and water solution to cause evaporation. Discuss what happened in each activity. Determine the kind of change that was observed (physical). . Heat a teaspoon of sugar in a container. Use high heat until sugar turns black. . Compare the contents with the results from the evaporation of sugar and water. Determine the kinds of changes that have taken place in each experiment. . Observe the sunlight. Explain that the energy of the sun is released by nuclear changes in the hydrogen at the center of the sun. Observe other effects of nuclear changes by looking at a watch or clock having

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		luminous numerals and hands. . Visit a nuclear-powered electric generating station. Have a person at the station tell how electric power is produced at the plant. . Write to your local power company for information on saving electricity. Plan to share this information with students in your school. (This may be done through announcements, posters, and/or dramatizations.)
B. Energy		
1. Energy is the ability to do work or to bring about a change in matter.	. Understand that the history of human development is the history of man's discovery of new sources of energy that he could use to do his work for him.	. Use reference books to make a mural of man's discovery of sources of energy through the ages, beginning with primitive man's use of fire.
2. Man is using more and more energy.	. Explain that the consumption of more and more energy is causing problems in production and supply.	. Publish a short "News Extra" for your school on ways to conserve energy. Let your publication reflect research, community

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		observations, and pictures to make your findings appeal to your readers.
C. Famous Scientists People who experiment have provided knowledge that has helped mankind.	. Understand and appreciate the work of scientists whose discoveries have led to interesting and beneficial discoveries in science.	. Use books and audiovisual materials to prepare a report on the life and work of these scientists. Use pictures to make your report interesting. a. Albert Einstein b. Henry Becquerel c. Otto Hahn and Fritz Strassman d. Pierre and Marie Curie Choose a scientist and prepare a dramatization of his/her life and work.
III. EARTH SCIENCE A. The Atmosphere 1. Air is a mixture of gases.	. Give the composition of the air.	. Make a chart showing the gases and the proportion of each gas--nitrogen, oxygen, argon, carbon dioxide, and other gases--that are found in the air.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. The atmosphere consists of layers.	. Explain that the conditions of the air vary in each layer of the air--troposphere, stratosphere, ionosphere, and exosphere.	. Make bulletin board display to show mileage and conditions in each layer of the atmosphere.
3. The temperature of the air determines the amount of water vapor the air can hold.	. Show that the capacity of air for containing water vapor depends directly upon the temperature.	. Use a hygrometer (a psychometer may be constructed) to determine the relative humidity of the air in the classroom. . From a table of Relative Humidity in percents, compute the relative humidity of the given readings of dry-bulb and wet-bulb thermometers.
4. The oceans of the earth and the air work together to cause the weather.	. Understand the interaction of air and water in producing weather.	. Use audiovisual materials to observe the water cycle. . Use a terrarium to explain the water cycle.
B. The Hydrosphere		
1. Oceanographers have determined that the difference in the amounts of energy absorbed by the different	. Learn that differences in temperature cause ocean currents.	. View a film or filmstrip on ocean currents and discuss causes of ocean currents. . On a map identify the location

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
parts of the ocean result in a wide range of temperatures in the oceans.		of some currents: Gulf Stream Current Canary Current Humbolt Current Indian Counter Current Equatorial Current
2. Pressure of ocean water increases with depth.	. Compute the pressure of ocean water by multiplying the depth of the water in centimeters times the density of water (1 gram per cubic centimeter).	. Determine the amount of pressure if the Bathyscaphe Trieste is at a depth of 100 meters.
C. Weather		
1. Small solid particles in the atmosphere act as nuclei on which water vapor condenses.	. Understand that vapor or ice crystals collect in the air to form a cloud.	. Observe the sky and make illustrations of the cloud formations you see. From a classroom chart or reference books determine the names of the clouds. Tell the kind of weather that is associated with each cloud. Now predict the kind of weather you might expect on a given day. . Use cotton to make the different kinds of cloud formations.
2. There are four main kinds of air masses	. Explain that the Polar Continental, Polar Maritime,	. On a map indicate the direction in which the air masses flow.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
that affect the weather over the United States.	Tropical Continental, and Tropical Maritime are air masses that affect the weather in the United States.	
	. Determine how fronts and high and low pressure areas affect the weather.	. On a weather map find the front and barometric pressure for your area. Make a prediction of what the weather might be. Check a meteorologist's report for accuracy.
3. A meteorologist must use instruments to help him make accurate predictions.	. Name several weather instruments and give their uses: thermometer rain gauge mecurial barometer- aneroid wind vane anemometer satellites hygrometer	. From various sources determine what information is gathered from each instrument. . Construct an anemometer and use it to estimate the wind speed. . Observe a wind vane. Note the direction of the wind.
4. The Weather Bureau aids the meteorologist in his work.	. Discuss the Weather Bureau as an agency of the government.	. Use reference material to learn about the functions of the Weather Bureau. Show ways the Weather Bureau aids the meteorologist in your area. . Have a person from the Weather Bureau visit the class and

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		discuss the work of the Weather Bureau.
5. Weather satellites are important in long-range weather predictions.	. Determine how local weather forecasting makes use of satellite information.	. Listen to the weather report for your area. Write down the span of time it covers. List ways this prediction might affect the activities of the people in your community. Note how this prediction might affect farming and food prices in your area.
D. Space 1. The universe is our solar system and galaxies of stars and nebulae are beyond our solar system.	. Understand that scientists use telescopes, radio telescopes, and space cameras to study objects in space.	. Use audiovisual materials, reference books, and interviews to gather information about instruments used in space study. . Telescopes--refracting, reflecting. Make an illustration to show how they differ. Examine a telescope to determine if it is a refracting or a reflecting telescope. Schmidt Camera Spectroscope Radio Telescope

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Note the information gathered from each instrument.
2. Space extends beyond the ionosphere.	. Understand that the conditions of space are different from atmospheric conditions on earth.	. On a chart or transparency compare the conditions of space--no atmosphere and pressure, temperature differences, etc.--to conditions on earth.
3. Rockets and spacecraft have become important tools in space probe research.	. Explain that spacecraft projects are designed to gather special information.	. Make a bulletin board display of the various space projects. Include the purpose of the projects and information gained from the program. . Invite a space expert to talk to the class about space exploration.
E. Effects of Space Research Space technology has brought many benefits to man.	. Recognize those areas in which space technology has been beneficial: a. weather b. communication c. medicine d. food	. Watch the television weather forecast. Determine what information was obtained from a weather satellite. . Watch television and make a list of those programs that come by satellite.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Invite a person from the telephone company to come and speak on current communication systems. . Interview a person who wears a pacemaker or invite one who wears a pacemaker to speak to the class. . Research to find out why those who wear pacemakers cannot enter buildings with certain equipment. . Make a display of foods that were developed as a result of space explorations. . Research careers that have come as a result of the space program. . Dramatize a work day in the life of a person in the year 2000 working in a space-oriented program.
F. Famous Scientists The work of many people has helped in the development	. Identify and appreciate the work of people who have made	. Use reference books and audio-visual materials to find out

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
of space.	important contributions to space exploration.	about the work of the following scientists: Nicholaus Capernicus Johannes Kepler Galileo Galilei Sir Isaac Newton Anders Celsius Robert H. Goddard Werner Von Braun Findings may be written in a report, illustrated on a mural, or presented in a dramatization.

AN INTRODUCTION TO SEVENTH GRADE LIFE SCIENCE

The seventh grade life science curriculum is a broad outline of concepts and learning activities which leaves open many techniques to be developed by the classroom teacher.

This curriculum is developed with the idea of making the student more aware of the living things around him and his role in the environment. The emphasis is on the total biotic community and the diversity that has occurred with the passage of time and the influence of man.

The course is open-ended and utilizes the student's ideas on space and his future on this planet.

SEVENTH GRADE

LIFE SCIENCE

I. THE LIVING BIOSPHERE

- A. Basic Elements of Ecology
- B. The Biotic Community
  - 1. Balance of nature
  - 2. Succession and the stable community
  - 3. Food chains and their links

II. LIVING THINGS IN THEIR ENVIRONMENT

- A. Fresh-Water Communities
  - 1. Life in a pond
  - 2. Life in a swiftly flowing stream
  - 3. Life in deep lakes
- B. Marine Communities
  - 1. Life in tidal and shallow water
  - 2. Life in the deep
- C. Land Communities
  - 1. Biogeography--altitude and latitude
  - 2. Life in community of man

III. CONTINUITY OF LIFE

- A. Continuity Through Genes
  - 1. Mendel's observations and experiments
  - 2. Nature of chromosomes and genes
  - 3. Cell division
- B. Changes in Hereditary Code
  - 1. Theories to account for evidences of change
  - 2. Variations and adaptations
  - 3. The sudden change--mutations
- C. Changing Man in a Changing Environment
  - 1. Plants and animal breeding
  - 2. Man--changing the environment

IV. ECOLOGY AND MAN

- A. Our Crowded Environment
- B. Land Use
- C. Waste Disposal
- D. Water and Its Use
- E. Air and Its Pollutants

V. BIOLOGY IN SPACE

A. Man in Space--Duplicating the Atmosphere
B. The Search
C. The Closed Ecological System
D. A Colony in Space

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. THE LIVING BIOSPHERE		
A. Basic Elements of Ecology		
1. The scope of ecology is the study of the relationship between living things and their environment.	. The student shall be able to recognize interrelationships between living organism and its environment.	. Use a plot on the school ground or a vacant lot to study the various living and non-living things within this environment.
2. The biosphere is the layer of living matter spanning the earth.	. The student shall construct a community illustrating the different niches of organisms living in this community.	. From the log kept on the plot, make a report on the abiotic factors involved.
3. All living things in the biosphere are joined together in a web of life.		
4. In the biosphere the living things can be classified as producers or consumers.	. The student shall be able to identify the producers and consumers in a given area.	. Select one organism and study its needs as supplied by its environment.
	. The student shall recognize the role of parasites and scavengers in the environment.	. Study what might happen if one source of food is lost to your given area.
5. Every living thing has its own niche.		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
6. The essential cycles within the biosphere are the carbon cycle, the water cycle, and the nitrogen cycle.	. The student shall recall the essential cycles of the biosphere.	
B. The Biotic Community		
1. Plants and animals living together in a particular place constitute a biotic community.	. The student shall be able to recognize the difference between an aquatic and terrestial community.	. Visit a pond in your community over a period of one month. Study its physical features as well as its biological activities.
2. Living things are joined together in communities.	. The student shall select a community and identify the stages of succession.	. Select one organism and show its biotic community and its role within the community.
3. Organisms differ in terms of structure according to their environment.		
4. There is a balance in nature within a stable community.		
5. The slow process that brings about a stable community is succession.		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
6. Within a stable community there may exist both symbiosis and antagonism.	. The student shall identify various forms of symbiosis and antagonism.	
7. Food is essential for all life.	. The student shall be able to identify a food chain and a food web.	. From a study of a pond or land plot, diagram a simple food chain.
8. All food is indirectly the product of green plants.	. The student shall demonstrate his understanding of a closed system by construction of a closed aquarium or terrarium.	. Establish aquaria, terraria, and closed systems to illustrate interdependence.
II. LIVING THINGS IN THEIR ENVIRONMENT		
A. Fresh-Water Communities		
1. The largest amount of food is produced in the water.	. The student shall demonstrate the proper use of a microscope.	. Plan as many field trips as possible, if only around the school yard. . Instruct students in proper use of the microscope.
2. Water movement and temperature determine types of life found in fresh water.	. The student shall recognize that life exists even though not visible to human eye.	. Have students observe samples of pond water and sketch the living organisms they can find in their samples.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. The student shall demonstrate that the amount of movement of water determines organisms that live in fresh water.	. By means of a water tank, simulate pond water movement and stream movement with sand on bottom of tank.
B. Marine Communities 1. Oceans are the most populated biomes of the world. 2. The amount of light that penetrates the water determines food. 3. Except in intertidal zones, temperature and salinity remain fairly constant.	. Different types of life exist in oceans because of tides and temperature.	. Discuss various foods that come from oceans and decide what part of the oceans they might live in.
C. Land Communities 1. The distribution of plants and animals varies according to latitude and altitude.	. The student shall be able to place in the appropriate biome various plants and animals.	. Hike around community and look at canopy, undestroyed undergrowth, and ground cover.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Biomes are large regions identified by climax vegetation.	. The student shall recognize that many organisms live in every small area of land.	. Lay out 1 meter square for each 3 students to investigate. List as many items as they can find in their area over period of 1 week.
3. Man has made changes in the earth's environment.	. The student shall become aware of the various influences man has on his community as it concerns plant and animal life.	. Study soil within chosen square meter.
III. CONTINUITY OF LIFE		
A. Continuity Through Genes		
1. An organism is the product of heredity and environment.	. The student shall recognize differences among organisms by activities with plants and animals.	. Grow a variety of plants under different environmental conditions.
2. The laws and principles formulated by Mendel stand as the basis of the science of genetics.	. The students shall be able to understand gene concept and theory of inheritance.	. Look carefully at eye color of each of the class members and arrange according to eye color.
3. Genes act as carriers of traits from one generation to another.		. Make a graph showing eye color versus number of students.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. Living things reproduce through cell division.	. The student shall be aware of the processes of mitosis and meiosis.	. Measure the height of each class member and draw a graph showing number of students versus the height of the students. . Make a Punnett square. . Have available audiovisual materials on cell division.
B. Changes in Hereditary Code		
1. There is a biological relationship among all organisms.	. The student shall be aware that living things change through the ages and are continually changing.	. Study the ear lobes of as many members of your family as possible. If there is more than one generation, draw a family tree with possible ear lobe shapes.
2. The hereditary code may be changed by either natural or artificial means.	. The student shall be aware of the great diversity of life.	
3. Changing environments, either natural or artificial, alter ecosystems.		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. Speciation may result from variation, migration, selection, and isolation.		
C. Changing Man in a Changing Environment		
1. New organisms may be produced by selectively crossing different species.	. The student shall be aware of selective breeding of plants and animals.	. Investigate improvement of plants and animals through selective breeding of natural mutations. Bring to class a seedless orange or a tangelo.
2. The knowledge of genetics has meant food for the starving and a healthier world.		. Look over seed catalogs for new varieties of plants.
IV. ECOLOGY AND MAN		
A. Our Crowded Environment		
1. The "population explosion" is a threat to man's survival.	. The student shall make an analysis of human population in order to identify any changes in the population.	. Do a census study to evaluate the human population trend in your city or county. . Obtain a county land map and figure percent of the county

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. There are links between population, productivity, and pollution.		land surface that is used by man for just his living area. . Discuss ways man misuses his land. . Make a survey to determine if pollution is a problem in your community.
B. Land Use As man's role in the environment changes, the use of the land changes.	. The student shall recognize land use within his county.	
C. Waste Disposal The disposal of solid waste often pollutes all aspects of the environment.	. The student shall describe the waste disposal method used by his township.	. From the survey suggest ways these pollution problems can be abolished.
D. Water and Its Use 1. Water is necessary for life.	. The student shall demonstrate his understanding of water pollutants by performing tests on a given water sample.	. Collect a water sample from an area within the community and test for as many pollutants as possible.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Water pollution is mostly man-made. 3. Water pollution is a hazard to man in many different ways.		
E. Air and Its Pollutants 1. Air is necessary for life. 2. Air which contains a large number of added particles and gases is considered polluted.	. The student shall be able to recall various pollutants.	. Have students suggest ways in which air pollutants might be diminished within your community.
V. BIOLOGY IN SPACE A. Man in Space 1. Space is not empty.	. The student shall be aware that space is not empty, just a different environment.	. By means of tube balloons, show various belts and layers around the earth.
2. Cosmic rays are constantly bombarding the earth's atmosphere.		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. A person going into space must take an earthly environment.	. The student shall demonstrate how much he would weigh in another environment.	. Calculate the weight of the student as if he were in space.
B. The Search 1. Space opens new frontiers of knowledge which may bring about many benefits. 2. Extraterrestrial life in any form may signal many advances in knowledge.		. List some of the items that the space program has developed which have benefited mankind so far.
C. The Closed Ecological System 1. The earth is a model of a closed ecological system. 2. Man's survival in space depends upon a closed system.	. The student shall recognize that a closed system is similar to a balanced aquarium or the space ship earth.	. Observe a closed aquarium and check conditions over a week.
D. A Colony in Space Man has the ability to take	. The student shall research the	. Organize class into committees

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
his environment to other areas in space.	problems of a satellite colony.	to research problems that would face space colony.
	. The student shall compile a file on the benefits to mankind from the space probes.	. Assign different students to the different benefits of space and have them compile a brief report. . Watch daily newspaper for up-to-date development in the space program.

EARTH-SPACE SCIENCE - EIGHTH GRADE

INTRODUCTION

Science for the eighth grade is an introductory and exploratory course in earth-space science. Many areas of earth-space science make up the content with each area explored sufficiently to enable the student to use the knowledge that he has gained in interpreting observations and events related to that area.

The life of the student is influenced each day by the advances made in earth-space science. Man has visited the moon and sent unmanned probes to other planets in our solar system. We are now discussing the problems involved in sending a manned probe to other planets as well as unmanned probes out of our solar system.

We have used our knowledge of space travel to enable us to make more accurate weather predictions. This improved weather predicting has saved many lives.

Earth-space science teachers realize that the investigatory approach is an important key to good science teaching. The activities included in the course of study are recommendations rather than mandates. Many earth-space science teachers have an extremely sophisticated repertoire of laboratory experiences which will complement the recommendations of this course of study.

EIGHTH GRADE

EARTH-SPACE SCIENCE

I. INTRODUCTION

- A. Scientific Investigation vs. Application (Technology)
- B. Scientific Skills and Attitudes
- C. Opportunities in Science

II. THE UNIVERSE--OVERVIEW

- A. Basic Observed Existences
  - 1. Void of space
  - 2. Matter
    - a. Properties
    - b. Structure
  - 3. Energy
    - a. Electromagnetic waves, gravity
    - b. Transfer of energy
- B. Investigation Instruments
- C. Inhabitants--Galaxies
- D. Theories of Dynamic Origin
  - 1. Big Bang
  - 2. Pulsating
  - 3. Steady State

III. STARS

- A. Life Cycle
- B. Constellations

IV. THE SUN

- A. Structure
- B. Production of Energy

V. THE MOON

VI. SPACE INVESTIGATIONS

- A. Unmanned
- B. Manned

VII. EARTH

- A. Lithosphere
  - 1. Time scale
  - 2. Fossil study
  - 3. Radioactive dating
- B. Hydrosphere

C. Atmosphere
    1. Composition
    2. Global wind patterns: Coriolis effect
    3. Precipitation

D. Resources

E. Location
    1. Longitude-Latitude
    2. Time determinations, global

F. Concerns for Life

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. INTRODUCTION A. Scientific Investigation vs. Application Seeking information uses sensory perceptions and some hypothesizing.	. Experience the conclusions derived from inconclusive evidence.	. Seal familiar objects (marbles, scissors, erasers) inside shoe boxes; let students investigate and conclude their contents. Emphasize thorough examination.
B. Scientific Skills and Attitudes Scientists find it helpful to approach a problem in organized stages.	. Participate in the solution of a problem by collecting and organizing data and drawing conclusions.	. Assign the problem of graphing numbers of students and families with month of birth to see if there are uneven distributions. (Compare several large groups' efforts.)
C. Scientific Careers 1. Scientists try to learn new things while technologists apply known science.	. Differentiate between careers that are purely scientific, purely technological, and a combination of both.	. Collect magazine pictures of workers and sort into categories of scientist, technician, skilled, and service. Make bulletin board.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. There are many careers in science.	. Familiarize students with scientific professions and prerequisites of each.	. Borrow nearby college catalogs from the guidance counselor and have several groups report on prerequisites for scientific study.
II. THE UNIVERSE--OVERVIEW		
A. Basic Observed Existences		
1. Matter has different forms and common properties.	. Observe and measure matter. Be able to differentiate density, state, and activity.	. Collect and display student samples of matter. Check properties. Burn and reweigh wood and paper. Conclude all matter has mass + volume.
2. Matter is arranged in systematic groupings.	. Recognize similarity of atom formation.	. Prepare a periodic chart of atoms exercise. Show students how to determine protons, electrons, and neutrons contained in every known atom. Isotopes can be introduced at this point also.
3. Atoms bond chemically to form molecules.	. Be able to show how molecules can be formed and broken.	. Use styrofoam balls of different sizes or colors and toothpicks or pipe cleaners cut into 5 cm lengths. Allow students to assemble molecules such as H_2O, CH_4, O_2, O_3, simple alcohols.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Decompose them to show that this also may occur.
4. Electromagnetic energy is one way to gather information about the universe and is useful on earth as well.	. Learn the electromagnetic spectrum and uses of each frequency area.	. Examine the prismatic separation of light into colors. Extend this information into a chart with properties, wave lengths, and frequencies of radio, infrared light, ultraviolet X-ray, gamma, and cosmic. Emphasize atmospheric windows which only permit light and radio easy access to earth.
5. Energy is evidenced only by its effects.	. Know many ways energy is "felt" on earth.	. Demonstrate energy forms and how they change forms. Energy amounts can vary the work done. Use lamps, mixer, chemical (burning) speaker, and others.
B. Investigation Instruments Several detectors supply astronomical information.	. Recognize the design and application of astronomical instruments.	. Demonstrate actual telescope, spectroscope if available. Assign groups to make poster showing the cut-away view of telescopes, spectroscope, radio telescope, and other frequency detectors.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Inhabitants--Galaxies		
1. Galaxies have a life cycle.	. Recognize the types of galaxies, their formation, and their comparative age.	. Obtain photos from magazines or galaxy kits to illustrate Hubble's classification of galaxy formation. Identify age by amount of gas (whiteness). Oldest are see-through galaxies.
2. The universe is everything we observe.	. Perceive the immensity of the universe and its contents.	. Use film, filmstrip, or tape describing space, distances, and terms such as galaxies, pulsars, nebula, quasars, black holes. . Visit a nearby planetarium.
D. Theories of Dynamic Origin		
1. Hypotheses change with the discovery of new facts that add to the understanding of natural processes.	. Define theory, hypothesis, and scientific laws.	. Allow students to state an hypothesis and list steps in developing it.
2. Scientific theories explain many related facts and are based on more evidence than hypotheses are.		. Assign student reports on researching the three prevalent theories of dynamic origin.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. Three prevalent theories of dynamic origin are Big Bang, Pulsating, and Steady State.		
III. STARS A. Star--Life Cycle Stars have a life cycle.	. Become aware of the relative ages of stars and be able to classify them according to age.	. Students chart (or study) Hurtsprung-Russell chart to trace the relative stages in a star's development.
B. Constellations 1. Most constellations bear mythological names.	. Share the stories behind the name of certain constellations.	. Assign each student a constellation and let him find the significance of the name.
2. Constellations are apparent patterns of stars.	. Recognize and locate several constellations in the night sky.	. Construct a model constellation by poking holes in shoeboxes (Diorama). . Take a night field trip. Using starmaps, find and identify the north star, big dipper, circumpolar constellations, and as many others as available. An amateur resource

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		person is available in most areas to help with this field trip.
IV. THE SUN A. Structure The solar system is widespread.	. Realize the distance between planets and the size variation.	. Make a model to scale. Attach cardboard planets. This should be done outside in groups. Teachers should have a scale for the model development.
B. Production of Energy Sun energy is a powerful equilibrium between fusion and gravity.	. Know how the sun power results from nuclear changes.	. Show film--"A Is For Atom"--from South Central Bell or Alabama Power.
V. THE MOON Moon phases reflect the sunlight from different positions in orbit.	. Understand the phasing of the moon and be able to predict which phase will be at any position.	. Demonstrate with spheres and light how visible sunlight can produce phase changes.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
VI. SPACE INVESTIGATION		
A. Unmanned		
Unmanned satellites and probes have contributed to earth's progress.	. Realize the wide applications of satellite feedback to mankind.	. NASA has several good films with this information. . Let students research and compile a list of areas where unmanned satellites have contributed.
B. Manned		
Manned explorations have extended knowledge of the universe.	. Survey the scope of manned expeditions.	. NASA films survey the manned ventures quite well. . List the many careers which contributed to the moon walks.
VII. EARTH		
A. Lithosphere		
1. Fossils are remains of organisms which once lived.	. Reproduce the natural method of fossil formation.	. Use seashells and leaves with clay to produce casts and fossil imprints.
2. Examples of layering of sedimentary rocks	. Demonstrate deposition of sediment and cementation with	. Use modeling clay (colored layers) to illustrate deposition, folding

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
are folding, faulting.	. subsequent deformation.	. (lateral pressure and faulting upward pressure quickly.)
3. Minerals form rocks.	. Understand the difference between minerals and rocks; be able to separate samples visibly.	. Crush a piece of granite and see if students can isolate mineral pieces of hornblende (black), feldspar (pink), and quartz (clear). . Show other varigated and homogenous samples to emphasize that rocks are mixtures of minerals (simplified).
4. Much life has developed in recent time.	. Absorb the rapid development of life since the earth's beginning.	. Make a model (like a thermometer) about 1 1/2 meter tall and mark it in millions of years (1 cm = 1 million years). Label the geologic eras and the appearances of note.
B. Hydrosphere Ocean currents occur in definite directions and spread heat toward the polar regions.	. Name and locate major ocean currents, their directions, and their temperature (warm, cold).	. On a map of the world using blue for cold and red for warm, indicate the name and draw arrows for direction of the five major cells of ocean circulation.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Atmosphere		
1. There are areas of prevailing wind on earth.	. Identify and explain the location and direction of the earth's wind belts.	. Spin a sphere (globe, ball) and drop water on it. Trace the direction of deflection to illustrate the Coriolis effect. . Make a transparency of the earth showing the rising air lows and descending air highs. Emphasize the Coriolis effect deflection on the wind belts.
2. Certain clouds indicate certain weather patterns.	. Predict precipitation, temperature, and pressure changes by cloud observations.	. From long range observation in the classroom, record cloud type and other weather conditions until general patterns are evident.
3. Weather prediction is sophisticated.	. Observe the complexity of weather stations.	. Visit a weather station and ask the weatherman to explain the devices he uses to obtain weather information.
D. Resources		
Earth resources are not evenly or plentifully distributed.	. Realize the need for international supervision and cooperation in sharing	. Consult an atlas to locate the distribution of such resources

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	available resources.	as timber, oil, coal, water, metals, and uranium. Try to find areas that could exchange resources.
E. Location		
1. Time determinations depend on location.	. Figure time from zone to zone on earth.	. Construct a time wheel by dividing a circle into 15° segments. Label a major city in each zone. Practice assigning a time in one city and have students respond with any other city.
2. Maps can give many kinds of useful information.	. Read and interpret several types of maps.	. Staple a list of questions which require students to read distance, elevation, symbols, etc. on several--topographic, aviation, rainfall--maps. Let groups compete to see which is most accurate. . Let each student make a map of his route to school. . Using rulers, ask students to scale some diagram up and down.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Get some plat sheets from the courthouse and let students locate some nearby building using township-range descriptions (listed on plat in courthouse).
F. Concerns for Life		
1. Man has some problems with the earth.	. Realize man's impact on nature and some future implications of his behavior.	. Shell, 21st Century, and other free-loan films specify and warn of these problems. (Order early.)
2. There could be life elsewhere in the universe.	. Imagine the implications to our society if new forms were discovered.	. Collect articles in newspapers and magazines which speculate about UFO's or life beyond earth. Discuss the possibilities and poll students for their opinions.
3. Resources should be conserved.	. Realize the possibilities of reuse of many resources.	. Survey locally to see how many reuse facilities you can identify. (Don't forget nature's recycling.)

SECTION THREE - PROGRAM FOR SCIENCE IN GRADES 9-12

BIOLOGY

INTRODUCTION

Students hunger for knowledge about life. Biology is a science which they can touch and experience firsthand. This course of study is designed to help the teacher to guide students to answers to their questions, to stimulate thought, and to help them develop into resourceful citizens.

This curriculum is by no means complete; however, it lends itself to many diversifications that may be presented by the teacher or the students. The course presents many investigative activities which require a minimum of laboratory equipment. Emphasis is placed on biological processes, biological relationships, and activities involving all living organisms.

BIOLOGY

I. NATURE OF LIFE

   A. The Living and Non-Living
   B. Cell Structure
   C. Chemistry of Life

II. ORGANISMS

   A. Life and Change
   B. Taxonomy
   C. Protist, Plants, and Animals

III. MAINTENANCE

   A. Nutrition and Digestion
   B. Circulation
   C. Respiration
   D. Excretion
   E. Locomotion

IV. REGULATION

   A. Homeostasis
   B. Stimulus and Response
   C. Behavior

V. CONTINUITY

   A. Cellular Reproduction
   B. Animal Development
   C. Plant Development
   D. Genetics

VI. EVOLUTION

   A. The History of Life
   B. The Origin of Life

VII. ECOLOGY

   A. The Web of Life
   B. Man and the Environment

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. NATURE OF LIFE		
A. The Living and Non-Living		
1. Biology is the study of life, and all organisms share a basic list of material characteristics The activities associated with these are known as physiological functions.	. Identify by name and function major structures that constitute plant and animal cells.	. Make a model of a cell by using as cell parts materials found in the classroom. . Compare solutions, suspensions, reversible, and irreversible colloids.
2. Protoplasm is a colloidal system.		
B. Cell Structure		
The cell is the smallest functioning unit of protoplasm.	. Be able to prepare slides of living or preserved cells and identify visible parts under low and high magnification. . Understand that protoplasm is a complex, continually changing mixture of substances which establishes the living condition.	. Demonstrate proper use of the microscope. . Prepare slides of living or preserved cells. . Have available for use by the class or for individuals as many types of audiovisual materials as possible.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Chemistry of Life		
1. Cell functions are essentially chemical in nature. 2. The chemistry of the cell results in the production of energy.	. Realize that energy is vital to all cell activities and that protoplasm is capable of converting potential energy into kinetic energy.	. Construct molecular models. . Diagram an atom or an ion given the appropriate data. . Demonstrate movement of molecules in and out of cells.
II. ORGANISMS		
A. Life and Change		
1. All organisms continually change in terms of adaptation to environment.	. Recognize change as function of life.	. Compare anatomical changes over the year in several species. . Examine fossil evidences in rocks. . Make drawing of protists that may be viewed under a microscope.
2. Changes in life are apparent through a number of evidences.	. Comprehend that some cells function independently as unicellular organisms, and other cells are interdependent in multicellular organisms.	

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
B. Taxonomy		
Taxonomy involves an artificial system of grouping for our own convenience.	. Conclude that scientists have devised various systems of classification that are universally used to show relationships in organisms.	. Show examples of Protozoa, Anthropods, and Chordata. Point out basic structures and characteristics that determine classification in that particular phyla. Show how members of the same phyla have structural adaptations for living in specific environments.
C. Protist, Plants, and Animals		
1. Living things are classified by many biologists into Kingdoms-Protist, Plants, and Animals.	. Be able to distinguish a variety of protists that may resemble plants or animals.	. Have students explain why all animals are ultimately dependent on plants.
2. Protists are a diverse group of organisms that encompass beneficial and harmful effects to man.	. Classify given organisms, both plant and animal, into their correct phyla with the aid of appropriate keys.	. Establish communities in the room--aquaria, terraria. . Prepare collections of plants or animals from the local environment.
3. Green plants are the source of food for all living organisms (directly or indirectly).		. Use well-planned field trips where applicable.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. Plants and animals have evolved from ascending complexity through the ages.		
III. MAINTENANCE A. Nutrition and Digestion		
1. All organisms must be able to fulfill certain basic needs, or they fail to survive.		. Grow variety of plants illustrating food production and food dependence.
2. Foods essential for living organisms vary, depending upon their metabolic processes unique to the species.	. Compare and contrast the nutritional patterns of organisms using examples that include protists, autotrophs, parasites, symbionts, and heterotrops.	. Illustrate phases of photosynthetic process. . Examine systems or models of systems where applicable.
3. Photosynthetic process is the basis for all food.	. Be able to construct food pyramids or food chains that illustrate the dependence of the high level consumers on the low level consumers and producers.	

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. A proper balance of chemicals is essential in maintaining appropriate metabolic processes essential to life.	. Trace the transfer of energy from one form to another as it moves through a series of organisms in different habitats. . Describe the mechanical and chemical processes that change large particles of food into soluble forms that can be diffused into living cells.	. Demonstrate the action of enzymes on foods. . Have students keep track of their diet for three days. . Using plants and animals, conduct experiments showing the importance of diet control.
B. Circulation Circulation is a process by which nutrients, gases, and waste materials are transported to and from organismic cells.	. Be able to trace the movement of food and water through plants and animals.	
C. Respiration 1. The chemical process of producing energy through oxidation is respiration.	. Relate respiration to energy in all living organisms.	. Have students investigate temperature change that takes place when seeds are soaked in water.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. The mechanical process of getting oxygen from the environment is breathing.	. Distinguish between aerobic and anaerobic respiration to the efficiency of energy release and products formed.	. Have students check how much air their lungs hold in one breath. . Investigate disorders of systems through a variety of student activities.
D. Excretion Excretion gets rid of wastes formed by metabolism and maintains the body's water balance.	. Recognize that body wastes are eliminated by different means.	
E. Locomotion 1. Locomotion is an adaptation to obtain food, a mate, shelter, and to flee from danger.	. Describe how movement is achieved by various forms of animals by use of cilia, flagella, pseudopodia, and muscles.	
2. Systems of locomotion show adaptations for land, water, and air.	. Compare and contrast the relative efficiency of internal and external skeletons. . Describe the major parts of the various systems and relate	

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	how these structures contribute to the well-being of the total organism.	
IV. REGULATION A. Homeostasis Numerous regulatory functions exist to maintain a condition of homeostasis which is essential to normal development and function.	. Recognize that life in the steady state is the result of constant regulation by hormones, nerve impulses, and proper removal of wastes.	. Investigate historical discoveries related to hormones and their importance in homeostasis. . Perform experiments with plants that show positive and negative tropisms.
B. Stimulus and Response Bodily functions are controlled by the integrally related activities of the voluntary and involuntary nervous system.	. Comprehend that many hormones are produced to chemically accelerate or inhibit life functions. . Describe the stimulus-response mechanisms in organisms such as paramicia, euglenae, planaria, earthworms, insects, and humans.	. Study the action of the sympathetic nervous system through the fight or flight responses. . Investigate studies of the influences of environment versus heredity. . Role-play various common human behaviors and discuss the responses.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Behavior		
1. Behavior is the product of inborn hereditary traits and environmental influences.	. Recognize that behavior is the sum of all responses which adapt living things to their environment.	. Have available live animals for students to touch and study.
2. Intelligent learning uses thinking, judgment, and memory.		
V. CONTINUITY		
A. Cellular Reproduction		
1. All cells have a systematic process for reproduction, either sexual or asexual.	. Identify and contrast the sequence of events in the mitosis of plants and animal somatic cells.	. Demonstrate through models, slides, and diagrams the systematic processes of mitosis and meiosis.
2. Cell growth is followed by cell division.	. Recognize that sex cells (gametes) are produced by meiotic cell division that reduces the diploid. . Understand the significance of asexual reproduction but appreciate the benefits of sexual reproduction in variation among offspring.	. Investigate a variety of organisms for specific characteristics. . Use models, charts, slides, developing embryos of both plants and animals to study the sequential development of organisms.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
B. Animal Development		
All animals reproduce and develop in a pattern characteristic to their species.	. Comprehend that mating and breeding patterns vary from species to species.	. Raise a litter of hamsters from conception to adulthood.
C. Plant Development		
All plants reproduce and develop in a pattern characteristic to their species.	. Be able to pollinate a seed plant and recognize other means of plant reproduction.	. Cross-pollinate a simple seed plant.
D. Genetics		
1. Hereditary characteristics are transmitted through an orderly sequence in accordance with an established pattern.	. Comprehend that inherited traits are not transmitted by the blood but through the genetic material contained in the nucleus of eggs and sperms.	. Investigate the work of Gregor Mendel through laboratory activities. . Investigate new strains of plants and animals through research. Discuss fruits such as tangelos, seedless oranges, etc.
2. Variations in living things are the results of changes in the genetic code acting in a changing environment.	. Appreciate that genetic material in the form of chromosomes can be seen in dividing cells, but discrete portions of each chromosome which control traits are called genes.	. Study simple gene traits such as tongue rolling and tasting tests.
3. Improvement of species characteristics is the	. Understand that chromosomes and	. Take the blood type of those

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
result of man's ability to control hereditary traits in plants and animals.	genes are theoretically composed of code molecules of DNA that have the ability to replicate themselves and to code RNA which controls protein synthesis. . Appreciate the value of improved breeds of plants and animals by practical application of the laws of genetics.	students who wish to have it done.
VI. EVOLUTION		
A. The History of Life		
1. Evolution represents changes in geological, biological, and cultural dimensions of the environment. 2. Geologic conditions evolved which established the conditions conducive to the origin and support of life.	. Recognize many evidences that life has changed on the earth and is still changing. . Comprehend that evolution has resulted in a wide variety of living organisms that have been able to survive or have become extinct.	. Collect and compare fossils available locally. . Show various audiovisual presentations of different evolutionary theories.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
B. The Origin of Life		
1. Life has developed from simple to more complex forms in accordance with the ability to survive in the existing environments.	. Be able to discuss how fossils show that life has developed from a simpler form.	
2. Communities have developed in accordance with structural and functional adaptability in regard to their needs.	. Discuss the various theories that have been developed to explain the cause of diversity of organisms as well as reasons for their adaptations.	
VII. ECOLOGY		
A. The Web of Life		
Variation and survival of life forms are predicated upon maintenance of appropriate environmental conditions.	. Realize that no organism exists as an entity separate and distinct from its environment, since a dynamic equilibrium exists in the interactions of organisms with themselves and with the environment. . Identify various factors that influence life forms: physical, chemical, and biological.	. Show effects of pollution in controlled lab activities. . Relate local environmental conditions to conservation needs and practices.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. Demonstrate an ecosystem as a living community and its non-living environment involved in an interaction among organisms, as well as a flow of energy and a cycling of materials. Trace the carbon-oxygen-hydrogen-nitrogen cycles as they exist in the biosphere.	
B. Man and the Environment		
1. Man faces problems in maintaining the steady state of the biosphere.	. Investigate factors that upset the balance of nature in an ecosystem, including man's activities.	. Have students report on both internally and externally caused disorders.
2. All living things depend on the environment for the conditions of life.	. Appreciate man's attempts to preserve plants and animals through efforts such as game preserves, national parks, hunting laws, fisheries, and other means of conservation.	. Do class surveys on current immunology of family members. . Show disease distribution and causes through various media including films.
3. Malfunction may be the result of either innate causes or those caused by infectious organisms.	. Contrast the various causes of diseases and their influence on the normal functioning organism.	

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. Acknowledge that man's future rests on the principles of ecology, which apply to plants and other animals as well as to man himself.	

INTRODUCTION TO CHEMISTRY

The study of chemistry provides the student with learning opportunities consistent with the objectives for science study. Chemistry offers opportunity for students to be involved in the learning process rather than be mere spectators, since the subject lends itself to varied activities. Also it provides greater opportunity for the development of skills in analysis, synthesis, and evaluation than is possible in some courses.

Specifically, chemistry is the organized investigation of the properties, composition, and structure of matter, of the changes that occur in matter, and of the energy absorbed or released during these changes.

Courses in chemistry can be designed for specific purposes, such as college and vocational preparation, consumer literacy, interdisciplinary studies, and special interest areas. These could be mini-courses, traditional in nature, or multilevel on an individualized basis.

Chemistry is a "doing" science, and its study cannot effectively be separated from hands-on laboratory experiences at any level that it is offered. Mathematics, being the language of science, should be employed in traditional and advanced courses. The depth of the treatment of the material depends on the goals for the course and the ability and background preparation of the students.

The teacher is the catalyst to bring the natural curiosity of the student into a motivational interaction with the learning activities to yield desired learning outcomes.

CHEMISTRY*

I. THE SCIENCE OF CHEMISTRY

- A. Experimental Science
- B. Methods
    1. Scientific method
    2. Laboratory
- C. Relationship to Other Subject Areas

II. MEASURING AND COMPUTING

- A. Metric System
- B. Mathematics
    1. Accuracy and precision
    2. Scientific notation
    3. Significant figures
    4. Ratio and variation

III. MATTER AND ENERGY

- A. Composition
- B. Properties of Matter
- C. Changes in Matter
- D. Forms of Matter
- E. Properties of Energy
- F. Forms of Energy
- G. Conservation of Matter and Energy

IV. THE MOLE

- A. Valence or Oxidation Numbers
- B. Formulas and Equations
- C. Gram-Formula Weights
- D. Molecular Composition
- E. Mass-Mass
- F. Heat and Physical Change
- G. Heat and Chemical Reaction

V. THE ATOM

- A. Fundamental Particles
- B. Models
    1. Early models
    2. Bohr (planetary)
    3. Wave-Mechanical (atomic and molecular orbital)
- C. Periodic Law
    1. Historical development
    2. Arrangements of the periodic table
    3. Predictive value

VI. CHEMICAL BONDING

- A. Types
    - 1. Ionic
    - 2. Covalent
    - 3. Metallic
- B. Nature

VII. GAS

- A. Boyle's Law
- B. Charles' Law
- C. Combined Gas Laws
- D. Mass-Volume Reactions
- E. Volume-Volume Reactions
- F. Kinetic Molecular Theory

VIII. CHEMICAL REACTIONS

- A. Chemical Energy
- B. Rates of Reaction
- C. Equilibrium
- D. Oxidation-Reduction and Electrochemistry

IX. SOLUBILITY AND IONIZATION

- A. Water
- B. Solution
    - 1. Properties
    - 2. Process
    - 3. Concentrations
- C. Ionization and Ionic Equilibrium
- D. Acids
- E. Bases
- F. Salts

X. ORGANIC CHEMISTRY

- A. Homologous Families and Functional Groups
- B. Derivatives of Hydrocarbons

XI. NUCLEAR CHEMISTRY

- A. Nature of Radiation
- B. Reactions

XII. CHEMICAL FAMILIES

- A. Metals
- B. Nonmetals
- C. Metalloids

*These units may be studied in a different sequence to fit the order of a general text. Many additional learning activities are desirable. This is not meant to limit the teacher's addition or substitution of other activities.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. THE SCIENCE OF CHEMISTRY		
A. Chemistry is an experimental science.	. Understand the procedures of scientific observation.	. View filmstrips, loops, 16mm on this and other concepts as available. . Propose hypotheses and plan tests to check them for the "Blue Bottle" Reaction. . Read Campbell's Why Do Chemical Reactions Occur. . Do the black box experiment (identification of objects sealed inside boxes, using senses other than sight). . Having sat in a place for 5 minutes, write a paragraph describing the usually unnoticed sounds that were observed.
B. Chemists solve problems in an orderly way.	. Acquire the attitudes of scientific investigation.	. Given an everyday personal problem, apply the traditional steps of the scientific method to its solution.
Chemistry is often studied in the laboratory.	. Develop familiarity with laboratory apparatus and skill in	. Given the commonly used laboratory equipment, draw, identify,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	using it.	and label.
	. Introduce routine laboratory techniques and safety procedures.	. From printed instructions demonstrate proper handling of glassware, techniques of pouring and handling solutions, and use of the gas burner. . From a filmstrip, tape, lecture, or reading, make notes on safety and first aid in the laboratory. . Write a poem related to safety or lack of it in the lab.
	. Develop skill in good record keeping of lab data and interpretation of data.	. For lab experiments record purpose, summary of procedure, and data appropriately organized using ink on a dated, bound, numbered page in a data book. . Write a formal lab report for required experiments including interpretation of data as instructed.
C. Chemistry is related to other subject matter areas.	. Develop an awareness of the impact that a knowledge of	. From articles from Chemistry (American Chemical Society

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CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	chemistry has on everyday life in many fields.	magazine publication) briefly relate the importance of chemistry to crime detection, communication, literature, or other approved topics (other periodicals if available).
II. MEASURING AND COMPUTING		
A. The metric system is a decimal system of measurement used by scientists throughout the world.	. Become familiar with the metric units (both elementary and derived) used in chemistry. . Develop skill in measurement using metric standards.	. Make a poster indicating the metric prefixes and the base units for the elementary measurement of mass, length, time, and temperature. Show the derived units for speed, volume, and density. . Measure items which would fit the description above and record.
B. All measurements are subject to error.	. Distinguish between the terms precision and accuracy in actual laboratory measurements.	. From actual measurements calculate density of pine wood, limestone, and water. Calculate the precision and the accuracy in percent error, using a Handbook of Chemistry for the accepted standard.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
In chemistry many very large and very small numbers must be used in computations and measurements.	. Place numbers in scientific notation and master addition, subtraction, multiplication, and division of numbers in scientific notation.	. On a duplicated assignment sheet write numbers in scientific notation. Solve problems of numbers in scientific notation and convert answers to proper form. Check answers with key.
All measurements are limited by the instrument used in measuring.	. Emphasize the importance of recording the degree of uncertainty in measurement.	. Read the volume of water in a 1 ml graduated pipette, in a 10 ml graduated cylinder, in a 100 ml graduated cylinder, in a 100 ml buret--each partially filled. Record the proper number of significant figures. Use other devices. Example--meter stick, triple beam balance, et.
Many properties of matter vary directly, inversely, or jointly to each other.	. Distinguish between types of ratio and variation.	. Make a list of properties that vary directly, inversely, jointly to each other (5 each).
III. MATTER AND ENERGY		
A. Matter is composed of elements and compounds (which are homogeneous) and mixtures (which may be	. Develop a fundamental understanding of the properties of matter-energy and the laws that explain their behavior.	. (Use as varied materials as are available.) Using closed vials, labeled A-O, by observation only classify:

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
heterogeneous or homogeneous).		1. as homogeneous/heterogeneous 2. solid/solution/unable to determine 3. element/compound/unable to determine.
B. Matter can be identified by characteristic physical and chemical properties.		. Using a 6 cm x 4 cm piece of aluminum foil, weigh, heat, and cut it into 6 even strips. Clean 3 with steel wool. Place 1 each, cleaned and not cleaned, in distilled water, HCl (6M) and NaOH (6M). Record observations. Describe the physical and chemical properties of aluminum.
C. Matter when changed may be altered in form or composition.		. Observe the following and determine if each change is physical or chemical: Heat each in a stoppered test tube with a match flame only. 1. 2-3 drops of water 2. 2-3 iodine crystals 3. several crystals of sugar 4. very small amount of starch 5. very small amount of sugar 6. small amount of paraffin.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
D. Matter may exist in the form of solids, liquids, gases, and plasma.		. Place a test tube 1/2 full of distilled water in a water bath of ice and ice cream salt. Measure temperature. Heat gradually, reading the temperature every 30 seconds for 20 minutes. Graph the time-temperature data. Interpret results.
E. Energy is a quality possessed by all matter which, under proper conditions, can be converted into work.		. Make observations of the following: Light a piece of magnesium ribbon on an asbestos square (Don't look directly at it!). Place a zinc and copper strip in a dilute HCl solution. Connect externally with a wire with a galvanometer between. Strike a first-aid cold pack. Pour 1 ml concentrated HCl into 5 ml water. Feel the outside of the tube.
F. Energy may be potential or kinetic in many forms such as heat, light, electricity, mechanical, chemical.		. Move a radiometer from a shady spot to a place in direct sun or in the beam of a projector light.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Using a burner, heat water whose steam is directed to turn a pinwheel. Describe the changes of forms of energy involved.
G. The toal amount of matter-energy in the universe is constant, and they are interconvertable.		. Read and summarize facts about the atomic furnace, the sun. . Give evidence to illustrate the laws of conservation of matter-energy, multiple proportions; define composition, inertia, combining volumes, Avagadro hypothesis.
IV. THE MOLE A. Atoms have a combining capacity when they form compounds.	. Develop an understanding and working knowledge of valence or oxidation numbers needed to write chemical formulas.	. Using an oxidation number or valence table, (1) predict two ions that would combine in a 1:1 ratio with calcium, lithium, sulfate ions and (2) that would combine in a 1:2 ratio with the above.
B. When elements combine, they form neutral compounds which	. Develop a working knowledge of formula writing based on	. Heat magnesium in a crucible until no further change is noted.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
may be represented by chemical formulas.	theoretical and experimental information.	Heat zinc and sulfur (thoroughly mixed) until a red glow is observed. Mix together solutions of silver nitrate and sodium chloride and observe. In each case predict the resulting products. Write formulas for each. . Devise a game of matching of positive and negative ions to form neutral compounds. . On a duplicated assignment sheet write formulas for the resulting compounds from reactants given.
Chemical reactions may be represented by balanced chemical equations.	. Develop the skill of writing balanced equations to represent chemical reactions.	. Write balanced equations from the reactions observed in the experiment above. . Write balanced chemical equations for assigned reactions involving no more than three reactants or products when given the formulas for the reactants and products of the reaction. . Identify each of the above equations as representing composition, decomposition, or displacement reactions.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. The mole represents one gram formula weight of a material, or 6.02×10^{23} molecules, and is represented by one chemical formula unit.	. Develop a basic understanding of the mole as an introduction to the quantitative aspects of chemical reactions and physical changes of state.	. Name the elements represented, the number of atoms of each element, and the mass of each element in one mole from formulas for any given compounds. . Given any two, calculate the third--moles, grams, and number of molecules. . Calculate the gram formula weight for each of the formulas listed: NaCl, $CaCl_2$, $Al_2(SO_4)_3$, $CuSO_4 \bullet 5H_2O$. . Calculate the percent composition for each of the compounds listed in the above.
D.-E. Chemical reactions involve predictable quantitative conversion of reactants to products in set ratios of moles, which can be represented by word or balanced chemical equations.		. Quantitatively determine the empirical formula of the tin-oxygen compound resulting from heating tin and nitric acid. . From percent composition data calculate the empirical formula. . Given percent composition and molecular weight, calculate the molecular formula of combining elements.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Correlate heights of resulting precipitates with the predictions of the number of moles of potassium iodide required to react completely with one mole of lead nitrate by heating 2 cc of lead nitrate with varying volumes of potassium iodide. Allow to settle and measure heights. Add 1 drop more of potassium iodide to each and observe. Repeat, using 4 cc of potassium iodide and varying amounts of lead nitrate. Add one more drop of lead nitrate. Observe. (Varying volumes in each case being 0.5 cc to 4.0 cc. 0.5 M solutions used.) . Calculate the mass, moles, molecules, or atoms for any reactant or product in a reaction from the chemical equation for the reaction and the corresponding mass, number of moles, number of molecules, or atoms for any other reactant or product. (Mass-Mass) . Demonstrate the mass-mass relationships of a reaction quantitatively collecting the

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		precipitate, lead chromate, from solutions made from .01 moles of lead nitrate and potassium chromate. Calculate theoretical yield and percent error.
F.-G. Energy changes occur with physical change and chemical reaction.		. Make data charts, graphs; interpret results for the following: Heat and then cool paradichlobenzene, a tube of which having been placed in a water bath. The temperature should be recorded every 30 seconds until melting and solidification occur respectively. . From graph above did a plateau occur? If so, propose a hypothesis to explain it. Apply knowledge of minimum energy and maximum randomness to the melting-freezing points of solids. . Calculate the change in energy when a given substance at a given temperature is changed to some new temperature in another phase when given the specific heat of the substance

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		in each phase, the heat of vaporization, and the heat of fusion of the substance. . In small groups discuss the following: Quantitatively what occurs during the phase change from a solid to a liquid in terms of (a) energy, (b) temperature, (c) distance between particles, (d) arrangement of particles, and (e) motion of particles. . Drop one crystal of potassium permanganate each into a test tube of tap water at room temperature and also into equal amount of hot water simultaneously. Observe for 15 minutes. Interpret results in terms of energy and randomness. . Formulate a definition of boiling based on observations in this experiment: Fill a 250 cc beaker 3/4 full of distilled water. Heat, recording temperature every 2 minutes for 6-10 minutes until a rolling boil is observed. Notice size, number, and location

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		of bubbles. Record barometric pressure. Graph time and temperature data. Interpret results. . Obtain 6 test tubes; add 5 cc distilled water to each. Add 1 gram of each of the following solids: ammonium chloride, calcium acetate, potassium nitrate, ammonium nitrate, potassium hydroxide, anhydrous copper sulfate. Record the maximum temperature change. Identify each as endothermic or exothermic. Propose a hypothesis to explain. . Calculate the molar heat of neutralization when 50 ml of 0.5M HCl solution is poured into 50 ml of 0.5M KOH solution using a styrofoam cup as a calorimeter. Record beginning and highest temperature change. (Assume 100 g equals weight of solutions.)
V. THE ATOM		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
A. Atoms are composed of the fundamental particles--the proton, electrons, neutrons, and mostly empty space.	. Understand the basic structure of matter.	. From atomic weights and atomic numbers figure the number of protons, neutrons, and electrons in various elements. . Construct a scale model or construct a mobile of the hydrogen atom in a long hallway. (Scale--nucleus, the size of a pinhead; the electron, 30 ft. away.) . Make a cross-word puzzle using information about the work related to atomic structure of the following: Democritus, Empedacles. John Dalton, J. J. Thomason, Robert Millikan, Eugen Goldstein, Wilhelm Wien, James Chadwick, Walter Bothe, Lord Ernest Rutherford, Frederick Goddy, Robert Moseley, Niels Bohr, Christian Huygens, Max Planck, Albert Einstein, Heisenberg, Schrodinger, DeBroglie, Lewis. . Read and report about how a mass spectrograph can be used to measure the relative mass

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		of minute particles. . Read about the research to produce atoms of elements 104 and 105. . Using a Crookes tube, show how a magnet deflects the path of the emission. How does this explain the concept of particle charge.
B. Through the years the use of various models have been produced to attempt to explain experimentally observed facts.	. Understand that the modern atomic theory has evolved from the work of many scientists through the years as new facts were discovered.	. Compare the basic beliefs of Aristotle, Rutherford, Bohr, and Schrodinger about the atom. . Make a poster illustrating a diatomic hydrogen molecule by the Bohr planetary model and the molecular orbital model. . Make a poster or bulletin board of atomic orbitals s and p probability shapes. . Using atomic numbers and an "order of filling" chart, illustrate the distribution of electrons by doing the following for elements atomic numbers 1-20: electron configuration, orbital notations, and electron dot (Lewis dot) diagrams.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Having done the above diagrams, compare the electron dot diagrams for the elements in the first column of the Periodic Table (IA), repeat for (IIA), (IIIA), (IVA), and through (VIIIA). Predict the electron dot diagram for Rb,I. Do the above diagram types to check predictions. . Examine a table of electronic configuration of the elements. All of the Transition Elements have the last electron filled into which orbital? For the Lanthanides and Actinides do the same.
C. Properties of atoms of elements are a periodic function of their atomic numbers; and when arranged by similar electron configurations, they form the modern periodic table which has predictive value.	. Illustrate the historical development of modern arrangement of and value of the periodic table.	. Outline the contributions of the following to the development of the modern periodic table: Johann Dobereiner, John Newlands, Lothar Meyer, Dmitri Mendeleev, Henry Moseley. . Examine the various periodic table arrangements in the teacher packet. Devise an entirely new arrangement. Use any creative arrangement.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Check out the "Box of Buttons." Devise as many bases for classification as you can think of. . Read in Chemistry magazine articles about the "islands of stability" predicted for elements 113 and 114 and "The Diagonal Relationships of the Periodic Table." . Describe the trend in electronegativity values of elements horizontally and vertically among elements in the periodic table. . Describe the trend in size of atomic radii on the same basis as above. . Describe the trend in ionization energies on the same basis. . Explain the three above in terms of size of nuclear charge, distance between nucleus and outer electrons, shielding effects of inner electrons, and sublevel of electrons.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. On the basis of presently known order of filling, predict the location in the periodic table, atomic number, and electron configuration of element 113. . Identify the groups whose last electrons fill the following sublevels - s, p, d, f. . Where in the periodic table are the metals, the nonmetals, the metalloids, the noble gases? . Use the quotation by Alexander Pope (1688-1744) as a topic sentence to describe the variations and regularities within the periodic table - "Where order in variety we see, and where, though all things differ, all agree."
VI. CHEMICAL BONDING A. Atoms of elements may be held together by chemical bonds which are ionic, covalent, or metallic.	. Understand concepts of chemical bonding based on theoretical predictions from electronegativity values and use of	. Using electronegativity values and a periodic table, rank-order the following bonded pairs from most ionic to

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	the periodic table; and	nonpolar covalent: Baron and carbon; cesium and fluorine; fluorine and silicon, bromine and bromine; hydrogen and chlorine; magnesium and nitrogen.
	. Obtain laboratory evidence for the relationship of bond types to solubility, chemical activity, and physical properties; and	. As examples of ionic and molecular crystals, use sodium cloride and paradichlobenzene to make the following comparisons: Feel the crystals between the fingers. Indicate hardness. Note odor (odor indicates ease of vaporization). Heat each gently, then strongly, for ease of melting. Compare solubilities in water, then in benzene. Chart data. On basis of results, generalize on the relative properties of molecular and ionic solids. Predict the type bonding as above and devise an experiment to test your predictions for iodine, sulfur, potassium iodide.
	. Understand unusual properties which do not fit other bonding	. Explain why metals exhibit the properties of conductivity,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	models for transition metals.	malleability, ductility, and lustre in terms of mobile electrons. . Discuss properties of the metallic bond, using the quotation of Geoffrey Chaucer from The Cantebury Tales to introduce the discussion: "But al thyng which that shineth as the gold tis not gold, as that I have herd it told."
B. Nature	. Understand the comparative nature of chemical bond types.	. Devise a table to compare the nature of the chemical bond types--covalent, ionic, and metallic. Use as headings the following: generally formed between, bond formed by, properties associated with, examples of substances utilizing bond type.
VII. GASES A. Volumes of dry, confined gases whose temperatures remain constant vary	. Attain a practical understanding of the laws governing the behavior of gases and a	. Use a plugged-up plastic syringe (pushed into a solid rubber stopper); replace

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
inversely with their pressure (Boyle's Law).	theoretical understanding of their mathematical relationships.	plunger. Note air "pushes back." Read volume. Add weights to top of plunger to cause pressure and decrease volume of air. Record data. Make as many readings as possible. Graph pressure (in grams) with volume in cm^3. Connect points with a smooth line. Infer type of variation indicated. . Explain how mercury barometers, aneroid barometers, altimeters in an airplane, siphons, and atomizers work. . Set up a demonstration to show how ordinary air pressure can crush a closed can.
B. At constant pressure the volume of a dry gas varies directly with the absolute temperature (Charles' Law).		. Use a flask of air at room temperature. Invert into a deep container of ice-water mixture. Notice the amount of water that enters the flask as the confined air cools. This can be done quantitatively, equalizing the pressure and correcting

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		for water vapor pressure. Resultant volumes can be graphed to determine type of variation. . Explain the following in terms of Charles' Law: why coke bottles burst on the delivery trucks in the summer, whether you add more or less air in auto tires before a trip in the summer as in winter.
C. The volume of a dry gas varies directly with the absolute temperature and inversely with the pressure.		. Calculate for a gaseous sample the value of the third item from data for two of the following (the number of moles being constant): (a) the pressure of the gas, (b) the volume, and (c) the temperature.
D.-E. Quantitative predictions involving reactants and products which are all gases or some gases can be made (mass-volume or volume-volume).		. Calculate mass, moles, or volume of any gaseous products or reactants from the equation for the reaction and the corresponding mass, moles, or volume of any of

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		the other reactants or products.
F. The average kinetic energy of molecules or atoms in a gas is the same for all particles at a particular temperature where kinetic energy may be related to mass and velocity by the formula $K.E.=1/2\ MV^2$. Different states of matter have differences in movement of particles.		. Compare relative diffusion rates of HCl and NH_4OH by inserting Q-tips soaked in equal amounts respectively at either end of a 30-60 cm clean glass tubing. A smoke ring of NH_4Cl will form where vapors meet. Distance each has moved can be measured. Make predictions before beginning. . Describe in quantitative terms how Kinetic Theory accounts for: (a) difference in gases and liquids, (b) pressure of a gas, (c) evaporation, (d) difference in diffusion rates for gases and liquids, (e) the ordinary observation that the boiling point increases with molecular weight, (f) the relationship between the rate of diffusion and molecular weight.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
VIII. CHEMICAL REACTIONS A. All matter possesses a certain amount of energy for each state in which it exists. The availability of free energy is a driving force of a reaction at any given temperature.	. Understand the driving forces in a chemical reaction.	. View a filmstrip on Thermochemistry. . Draw typical energy diagrams for an endothermic and an exothermic reaction. . Chart the different kinds of energy-kinetic, potential (chemical binding forces), and nuclear with their sources. . Compare the Gambler's Laws of Thermodynamics--(1) You Can't Win, (2) You Can't Even Break Even, and (3) When You're Flat Broke You Can't Lose Any More--with the relationship of change in free energy and the three laws of Thermodynamics. . Discuss in terms of enthalpy the following: stability of compounds, bond energy (forming vs. breaking), heat of formation, combustion reaction, solution, neutralization,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Hess' Law. . Ralph Waldo Emerson said, "For the world was built in order and the atoms march in tune." Use this as a topic sentence for a discussion of driving forces of chemical reactions.
B. Rates of Reactions	. Realize the factors that affect the rate of a reaction.	. Perform a spectacular "clock" reaction, such as the iodine or formaldehyde clock reactions. Vary temperatures, concentrations, use of catalyst. Interpret results in terms of effect on rate. . Prepare for a question box exercise where each student will spontaneously answer a question pulled from a box, gaining a set number of points if correct. If incorrect, the first person to give the correct answer gets the points. The general topic will be the factors affecting chemical reaction rates.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. A chemical equilibrium consists of two dynamic opposite reactions in a closed system which occur at equal rates and may be upset by various factors.	. Understand how to recognize an equilibrium situation and the factors which would alter it.	. Explain in terms of LeChatelier's principle why a weighted wire will cut through a large block of ice which will refreeze above the wire as it passes through. Do this demonstration. . In small groups discuss, list, and rank-order ideas; then be prepared to share with other groups the following: Our daily lives are directly affected by thermodynamics, kinetics, and equilibrium. . Use four flat-bottom (2 cm x 4 cm) vials. Label two "A" and two "B". Pour 3 cc of ammonia water (ammonium hydroxide) into each "A". Pour 3 cc tap water into each "B". Add 1 drop of phenolphthalein and stir. Place one "A" and "B" close together. Cover with a 250 cc beaker. Place another "A" and "B" close together uncovered. Record observations for 30

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		minutes. Interpret. Describe the macroscopic and microscopic behavior of a system in equilibrium. . Predict the change that will result in a system at equilibrium when any of the following occur: (a) the concentration of one of the components is changed, (b) the pressure in the system is changed, (c) the thermal energy is changed, or (d) a catalyst is added to the system. . Write the equilibrium constant expression from the equation for a reaction. . From a list of reactions and their equilibrium constants, rank the reactions in order of decreasing concentration of products at equilibrium.
D. A large class of reactions involve the transfer of electrons. These are called redox reactions	. Understand the theoretical aspects of redox reactions and their practical applications to everyday life.	. For any reaction involving oxidation and reduction, identify the reactant that is oxidized, the reactant

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
and involve oxidation and reduction half-reactions.		that is reduced, the product of the oxidation, and the product of the reduction. . Design and demonstrate a procedure for obtaining electricity from a chemical system using two metals and aqueous solutions of their salts. . Identify from a list of chemical equations those which represent oxidation-reduction (redox) reactions. . Use the results of the investigation to propose a procedure for eliminating (or slowing) some oxidation, such as the rusting of water pipes and/or for inducing (or speeding up) oxidation, such as the rusting of metal cans. . List examples of reactions involving oxidation and reduction that are necessary for human existence and/or physical comfort. . List examples of reactions involving oxidation and reduction that are detrimental to human

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		existence and/or physical comfort. . Briefly describe some practical applications of electrochemistry; for example, the dry cell, storage cells, metal plating, electroanalysis, industrial electrolysis, corrosion. . After conducting an investigation using lab equipment, strips of various metals, and aqueous solutions of corresponding metal ions, (a) write equations for the half reactions which occur when any of the metal strips are placed in any solution containing one of these ions and (b) order the resulting half reactions in decreasing order to ease off oxidation.
IX. SOLUBILITY AND IONIZATION A. Water is the most common solvent.	. Gain an appreciation of water as unique common solvent.	. List physical and chemical properties of water that make it a unique common solvent. . Construct an inference about

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		the various bonds that must exist in a substance in order for it to act as an emulsifying, cleaning, and/or wetting agent.
B. A true solution is a homogeneous molecular dispersion consisting of two or more substances mixed in various proportions and having colligative properties.	. Understand the colligative properties of solutions, the process of solution, and ways of expressing concentration of solution on a theoretical and practical basis.	. Distinguish between concentration of an acid and strength of a solution. . Experiment with molecular (polar and nonpolar) and ionic solutes and solvents to determine the specificity trends. . Experiment with various materials to determine conductivity properties of various solutions. . Describe how the nature of the chemical bonds in a solute relates to (a) its solubility in various solvents, (b) conductivity, and (c) colligative properties. . Determine the number of moles and the molarity of each species present in an ionic solution

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		formed by adding a known mass of solute to form a known volume of solution. . Using solubility curve tables, predict the solubility at varying temperatures.
C. In solution, electrolytes conduct electric currents because they contain ions.	. Have general understanding of ionic equilibrium and reactions that go to completion.	. Perform experiments related to the following: 1. Boiling-freezing point changes 2. Common ion effect 3. K_{sp} 4. pH of solutions and Kw
D.-E.-F. There are several models which describe the properties of acids and bases which, when combined, form salt solutions.	. Understand the Arrhenius, Bronsted-Lowery, and Lewis Acid-Base Models methods of measuring their concentration and their practical application to everyday life.	. Construct an operational definition of acids and bases; use it to classify common substances found in the home. Obtain and test with common indicator. . Identify from a list of equations for simple chemical reaction those substances (reactants or products) that would be considered acids and bases as defined by:

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		(a) Arrhenius, (b) Bronsted and Lowery, (c) Lewis. . Do successive titration of three equal samples of standardized dilution which agree within the limits of the uncertainty of measurements of the apparatus used. . Predict approximate pH of each dissolved salt. Test with litmus and hydrion papers. . Svante Arrhenius said, "Solutions fill the oceans, solutions are running in our veins..." Explain in terms of the study of solutions and ionization.
X. ORGANIC CHEMISTRY		
A.-B. Carbon compounds may be classified into structurally similar families which may also contain substituted functional groups and undergo various	. Have a basic understanding of what organic chemistry is, how its study differs from inorganic chemistry, and how extremely important organic products are to everyday life.	. Construct ball and stick models for a number of organic compounds; some compounds in the list should contain double or triple bonds.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
organic reactions.		. Construct ball and stick models of at least two compounds which are stereoisomers and explain (in terms of a model) why these compounds have different properties even though they have the same formula. . Demonstrate that the chemistry of many organic compounds can be understood (in large part) by studying the functional groups in the compound through performing a number of syntheses such as: (a) esterification, (b) saponification, (c) limited oxidation of alcohols, (d) peptidization, and (e) synthetic polymerization. . Use the detergent, pesticide, packaging, and/or fertilizer industry to illustrate how man's use of chemical knowledge to improve his well-being has led to other problems for him and identify types of data that should be analyzed and projected in the future before any new product

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		should be marketed for mass consumption. . Identify and describe various ways natural chemical processes in the living organism may be affected by the presence of foreign chemical substances within the organism. . Take any shelf at home. List everything on it. Classify as organic or inorganic. . Take any room in the house. Mentally eliminate any synthetic item or part of an item. List what remains.
XI. NUCLEAR CHEMISTRY A. Nuclear changes are accompanied by conversion of matter into energy involving changes in the nuclei of atoms.	. Have a basic understanding of the difference in the matter-energy changes between chemical and nuclear reactions.	. In a table summarize the various emissions from unstable nuclei along with their symbol, charge, mass and approximate relative penetrating power. . From reference materials

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		list other subatomic particles along with their mass, charge, and lifetime. . Report on various methods of detecting radiation.
B. Nuclear reactions may occur naturally or be induced.	. Differentiate between the natural and artificial nuclear reactions and determine them to be useful/useless or safe/dangerous.	. Write equations to represent nuclear transformation resulting in natural decay of radioactive materials. . Write equations to represent nuclear transformations that are capable of sustaining a chain reaction. . Predict from a list of various atoms (with atomic number and mass indicated) those which should have nuclear stability and those which should not. . Discuss possible applications of nuclear transformations including factors that must be considered in order to judge whether the application is "useful or useless" and "safe or dangerous."

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Differentiate between nuclear decay, fission, fusion as related to cause, effect, application.
XII. CHEMICAL FAMILIES		
A.-B.-C. Because of common properties, elements may be classified and studied by families. Generally all elements may be identified as metals, nonmetals, or metalloids.	. Further correlate physical and chemical properties with placement in the periodic table.	. Review the families of elements in the vertical columns of the periodic table and common properties of each.
	. Provide experience in separating and identifying cations and anions in water solutions.	. Using a simplified procedure for qualitative analysis, test for the following anions: Group I II III CO_3^{-2} CrO_4^{-2} Cl^{-1} NO_2^{-1} PO_4^{-3} Br^{-1} SO_3^{-1} SO_4^{-2} I^{-1} S^{-2}

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Group IV NO_3^{-1} $C_2H_3O_2^{-1}$ ClO_3^{-1} Repeat for cations Group I II III Ag^{+1} Cu^{+2} Cr^{+3} Hg_2^{+2} Hg^{+2} Al^{+3} Pb^{+2} Sb^{+3} Fe^{+3} Group IV V Co^{+2} Sr^{+2} Ni^{+2} Ba^{+2} Zn^{+2} ca^{+2} Mn^{+2}
	. Recognize the practical application of the occurrence and uses of matter in everyday life.	. Taking each group, give some industrial and consumer uses for typical member, mentioning

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		particularly those elements classed as metalloids.

PHYSICAL SCIENCE

I. INTRODUCTION TO PHYSICAL SCIENCE

- A. Accuracy of Measurement
- B. Scientific Notation
- C. Metric System
- D. Graphing Variation

II. THE ATOM

- A. Properties of Matter
- B. Atomic Structure
  - 1. Development of knowledge of the atom
  - 2. General structure
  - 3. Electron configuration
- C. Isotopes
- D. Radioactivity
  - 1. Development of knowledge of radiation
  - 2. Causes of natural radioactivity
  - 3. Types of radiation
  - 4. Detection and measurement
- E. Fission
- F. Fusion
- G. Nuclear Reactors
- H. Useful Applications of Radioactive Isotopes
- I. Protection from Radiation

III. INORGANIC CHEMISTRY

- A. Periodic Chart of Elements
- B. Chemical Properties
- C. Changes in Matter
  - 1. Physical change
  - 2. Chemical change
  - 3. Compounds and mixtures
- D. Valence of Oxidation Number
  - 1. Valence electrons
  - 2. Bonding
- E. Chemical Shorthand
  - 1. Symbols
  - 2. Formulas
  - 3. Equations
- F. Chemical Compounds
  - 1. Acids
  - 2. Bases
  - 3. Salts
- G. Solutions

IV. ORGANIC CHEMISTRY
    A. Definition
    B. Hydrocarbons
        1. Crude oil and coal
        2. Fractionation

V. MECHANICS

    A. Work
    B. Energy
    C. Power
    D. Machines
        1. Functions
        2. Types
        3. Mechanical advantage
        4. Efficiency
    E. Motion
        1. Frames of reference
        2. Velocity
        3. Acceleration
    F. Centrifugal and Centripetal Forces
    G. Mechanics of Fluids
        1. Fluid pressure
        2. Pascal's Law
        3. Archimedes' Principle

VI. HEAT

    A. The Nature of Heat
    B. Measurement of Heat and Temperature
    C. Heat Transfer
    D. Change of State
    E. Expansion and Contraction

VII. SOUND AND WAVE ACTION

    A. Nature of Sound
    B. Characteristics of Sound
    C. Sound Phenomena

VIII. LIGHT

    A. Nature of Light
    B. Reflection of Light
    C. Refraction of Light

IX. MAGNETISM AND ELECTRICITY

- A. Magnetism
  - 1. Nature of magnetism
  - 2. Magnetic poles
  - 3. Types of magnets
  - 4. Magnetic fields and lines of force
- B. Electricity
  - 1. Static electricity
  - 2. Current electricity
  - 3. Conductors and nonconductors
- C. Electric Generators and Motors
- D. Measuring Electricity
- E. Ohm's Law
- F. Series and Parallel Circuits
- G. Controlling Electric Current
- H. Energy Conservation

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. INTRODUCTION TO PHYSICAL SCIENCE		
A. Accuracy of Measurement Accuracy in measurement is an integral part of the scientific process.	. The student will describe the possible results of an inaccurate measurement during a science experiment.	. Demonstrate acceptable methods to measure that will help assure accuracy.
B. Scientific Notation Scientific notation is a method of writing numerals using exponents.	. The student will show an understanding of exponents.	. Solve problems using exponents. . Stress exponents in all experiments and problems.
C. Metric System 1. SI metric units are based on the decimal system.	. The student will demonstrate ability to measure in metric units.	. Have students measure and record units for variety of objects.
2. In the SI metric system the base units are the meter, kilogram, second, and degree Celsius.	. The student will be able to measure practical objects and express these measurements in square and cubic metric units.	. Show a metric film. . Have a field day and express races in metric units.
3. Derived units are formed from base units and include liter, m^2, m^3,		. Use crossword puzzles and games to teach metric units.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
velocity, and others.		
D. Graphing Variation A graph is a pictorial representation of two known quantities.	. The student will demonstrate ability to graph the results of experiments.	. Set up experiments and have students graph results.
II. THE ATOM A. Properties of Matter 1. Each form of matter has general properties such as mass, inertia, and volume.	. The student will differentiate between general and specific properties of matter.	. Weigh and measure a certain amount of water to illustrate general properties.
2. Each form of matter has different chemical and physical properties from all other matter.		. Change water from solid to liquid to gas in order to portray major states of matter. . Determine the density of several different solids and liquids. . Demonstrate the comparative activity of sodium and tin.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
B. Atomic Structure		
1. John Dalton proposed the atomic theory.	. The student will be able to list contributions of early scientists to the development of the atomic theory.	. Allow students to volunteer to give reports on John Dalton, Avogadro, and Lothan Meyer or do role play depicting the contribution of these early scientists.
2. The atomic nucleus is very small and is made up of positively charged particles called protons and neutral particles called neutrons. The atomic number of an element is equal to the number of protons in its nucleus.	. The student will explain the construction of an atom of a common substance such as oxygen.	. Allow students to develop atomic models using wire and styrofoam balls or draw charts.
3. Electrons are negatively charged particles located in shells or energy levels.	. The student will demonstrate an understanding of atomic structure by drawing the electron configuration of elements in the first two periods on the periodic table.	. Require students to draw the atomic models for several elements. . Show the film "A is for Atom."
C. Isotopes		
1. Isotopes of an element	. The student will be able to	. Allow students to develop models

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
have the same number of protons and electrons but have different neutron counts.	recognize isotopes of elements.	of several isotopes.
2. Some isotopes are radioactive.		. Use a Geiger counter to show effect of radioisotopes.
D. Radioactivity		
1. Henry Becquerel was one of many scientists who have added to man's knowledge about radioactivity.	. The student will be able to list the main contributions of Becquerel, Roentgen, Pierre and Marie Curie, and others.	. Assign reports on scientists who have discovered ideas about radioactivity.
2. Radiation is the result of changes that occur within the nucleus of certain atoms.	. The student will list the possible causes for unstable nuclei.	. Use previously made models and the periodic chart when introducing radioactivity.
3. Alpha and beta particles and gamma rays are three types of radiation given off by radioactive materials.	. The student will explain the types of radiation.	. Work with Geiger counters and sources of alpha, beta, and gamma radiation to show effects of shielding, time, and distance.
4. Radiation can be detected with an electroscope, Geiger	. The student will explain how radiation is detected by the instrument he uses in the	. Use the Geiger counter to demonstrate varying amounts of radiation.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
counter, cloud chamber, bubble chamber, and photographic emulsion.	laboratory.	
The Curie is the unit for measuring the disintegration rate of radioactive substances. The Roentgen is the unit for measuring exposure to radiation.	. The student will define Curie and Roentgen and give an example of each.	. Show a film or filmstrip about radiation. . Obtain materials, build a cloud chamber, and demonstrate. . Work with an X-ray technician to illustrate photographic effects of radiation on X-ray film.
E. Fission		
1. Fission occurs when an atom is split with a tremendous release of heat, light, and nuclear energy.	. The student will be able to explain the source of energy in a fission reaction.	. Use visual diagram to illustrate fission.
2. Fission can be used for bomb production or for power production and peaceful purposes.	. The student will describe how electricity can be produced by radioactive materials.	. Show a film about atomic bombs and power production. . Play role-playing games about using atomic power for electrical production.
3. Environmental problems accompanying nuclear power plants need to be	. The student will write a brief report on the pro's and con's of nuclear power plants.	. Visit an atomic power plant or

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
carefully evaluated.		invite a speaker to visit the classroom. . Invite resource person from agency such as EPA to discuss problems.
F. Fusion The process of combining nuclei is called fusion and releases tremendous amounts of energy.	. The student will be able to explain the energy obtained from fusion.	. Allow students to do current research on the technology of using fusion reactions for power production.
G. Nuclear Reactors A nuclear reactor is a device which allows nuclear fission to occur at a controlled rate to produce electricity and power.	. The student will name the parts of a reactor and tell how it works.	. Build a scale model of a nuclear reactor; show films and filmstrips. . Have students do reports on civilian and military uses of nuclear reactors.
H. Useful Applications of Radioactive Isotopes		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
There are many useful applications of radioisotopes in medicine, in industry, and in the military services.	. The student will list the useful applications of radioisotopes.	. Group students by interest area and research uses of isotopes.
I. Protection from Radiation		
1. Radiation can cause sickness or death.	. The student should be able to recognize the causes and symptoms of radiation sickness.	. Contact your local civil defense director and request films, talks, and literature.
2. Time, distance, and shielding are necessary protection measures from fission bombs.	. The student can locate the safest place to go in a nuclear emergency and can outline safety procedures to follow.	. Simulate the necessary procedures following a nuclear attack.
III. INORGANIC CHEMISTRY		
A. Periodic Chart of Elements		
1. Mendeleev organized the periodic table according to the atomic masses of the elements.	. Using the periodic table, the students will be able to explain why an element is placed where it is.	. Show a film that describes historical development of the periodic table. (If one is not available, look for a film or filmstrip about Mendeleev and Moseley.)
2. Based on Moseley's research the periodic table is now arranged according to the atomic numbers of the elements.		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. Properties of elements are periodic functions of their atomic numbers.	. The student will state in his own words what "properties of elements are periodic functions of their atomic numbers" means.	
4. In the modern periodic table families of elements occur in columns and periods of elements occur in rows.	. The student will be able to select metals, non metals, and inert gases from the periodic table.	. Demonstrate the reactivity of sodium and potassium and fluorine and chlorine.
B. Chemical Properties Chemical properties of a substance determine its reaction with other materials.	. The student will be able to infer that the reactibility of an element and its location on the periodic table are related.	. Compare the reaction of a very active metal (Na or K, eg.) with water and the reaction of steel wool with water by demonstration.
C. Changes in Matter 1. Change in the size, shape, form, volume, or appearance of a substance without changing its composition is a physical change.	. After a brief demonstration the student will tell which change is physical and which is chemical.	. Do a series of experiments indicating physical and chemical changes.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. A chemical change occurs when two or more substances combine to form a new substance with different properties.		
3. A mixture is a combination of two or more materials that are not chemically united. When two or more elements are chemically combined, a compound is formed.	. The student will be able to differentiate between compounds and mixtures and give examples of each.	. Mix sulfur and iron filings together and separate the mixture into its components with a magnet. . Burn sulfur to demonstrate compound formation.
D. Valence of Oxidation Number		
1. Valence electrons are the number of electrons that an atom gains, loses, or shares in combining with another atom. Electrons are transferred or shared in order for elements to have complete outer shells (shells of eight electrons).	. The student will list the valences for the common elements based on their family positions in the periodic table.	. Make and display a chart of the valences of common elements and ions. . Review periodic table stressing the relationships of valence electrons to family groupings.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Ionic bonding occurs when electrons are transferred from one atom to another. Covalent bonds are formed when electrons are shared between atoms.	. The student will be able to select compounds having ionic and covalent bonding from atomic diagrams.	. Have students draw atomic diagrams of several compounds illustrating ionic and covalent bonding.
E. Chemical Shorthand		
1. Chemical symbols are abbreviations for the names of elements and are used in chemical formulas.	. The student will recognize selected elements (most common) by their symbols.	. Have students devise a game to reinforce the learning of the selected symbols most frequently used in class.
2. A chemical formula indicates what elements are present in a molecule and how many atoms of each element.	. Using the periodic table, the student will write correct formulas for selected compounds.	. Make a poster to display formulas for selected compounds. . Display bottles and cans of common substances (lye, baking soda, etc.) with formulas written on a slip of paper attached to each.
In molecules positive and negative valences must total zero.		. Assign students a project to bring in a list of items at home along with formulas of each.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. A chemical equation is a shorthand method of describing a chemical reaction.	. The student should be able to translate a chemical equation into an ordinary English sentence.	. Perform experiments representing the different types of chemical reactions and explain the respective equations.
A chemical equation not only describes a reaction but designates amounts of materials involved.	. The student will be able to explain what is meant by a balanced equation.	
F. Chemical Compounds		
1. Acids are compounds that have certain properties in common and turn blue litmus paper red.	. The student will be able to contrast the properties of acids and bases.	. Have students bring in household products and medicines to classify as acids or bases by using litmus paper.
2. Bases are compounds that have certain properties in common and turn red litmus paper blue.	. By using indicators, the student will determine what is acidic and what is basic.	. Test some soil for P^H and discuss the relationship to plant growth.
3. Salts are products of reactions between acids and bases.	. The student will define a neutralization reaction.	. Make a collage depicting common salts.
G. Solutions		
1. Solutions are homogenous mixtures that may vary	. The student will be able to define solute, solvent,	. Make a supersaturated solution of water and "hypo" to show

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
in concentration.	saturated, supersaturated, and unsaturated solutions.	supersaturation.
2. The solution process may be affected by different factors.	. The student will interpret a graph that shows how an increase in temperature affects solubility.	. Demonstrate the effect of heat, stirring, and particle size on the rate of dissolving.
3. Certain compounds dissolved in water form ions and conduct an electric current.	. The student will be able to relate ionization to electrical conductivity.	. Demonstrate the electrical conductivity of a water solution of NACl.
IV. ORGANIC CHEMISTRY A. Definition Organic chemistry is a study of compounds composed of carbon combined with other elements.	. The student will be able to identify organic compounds from a list of formulas.	. Discuss importance of carbon compounds.
B. Hydrocarbons 1. Crude oil and coal are the major sources of hydrocarbons, and each	. The student will be able to list a variety of products which are produced from crude	. Make a display of plastic materials. Get students to research biodegradable plastics and debate

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
produces many useful products.	. oil and/or coal and state uses.	. throw-away vs. recycled containers.
		. Make posters depicting products that come from crude oil and coal.
2. Crude oil is refined by fractionation.	. The student will be able to differentiate between cracking and polymerization.	
V. MECHANICS		
A. Work		
Work is accomplished when a force is applied over a distance.	. The student will define work and solve elementary problems.	. Lift several different objects and calculate the amount of work accomplished in metric units.
B. Energy		
1. Energy is the ability to do work.		. Demonstrate various forms of kinetic and potential energy.
2. Energy of motion is kinetic and stored	. The student will define kinetic and potential energy and give	. Solve problems dealing with kinetic energy (using

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
energy is potential.	examples of each.	motorcycles) and potential energy.
C. Power		
1. Power is the time rate of doing work. (Power = Work/Time)	. The student will solve elementary problems.	. Get students to figure their power in metric units (watts or kilowatts) while running up a flight of stairs.
2. The watt is a measure of power in the metric system.		. Assign students research on the power of new automobiles and rocket engines.
D. Machines		
1. A machine is a device to increase the amount of force, change the direction of force, or increase the speed and distance of force.	. The student will give examples to illustrate the three ways machines help man.	. Visit a garage or vocational school for a first-hand look at different types of machines in operation.
2. All machines are based on the six simple machines.	. The student will recognize the six simple machines.	. Make a display of items that employ the six simple machines. . Set up a demonstration using each simple machine.

CONCEPTS	DESIRED LEAR	ACTIVITIES
3. The mechanical advantage of a machine is the number of times the effort force is multiplied.	. The student will be able to calculate the mechanical advantage in simple problems.	. Figure the mechanical advantage of a bicycle.
4. The efficiency of a machine is the ratio of ideal to actual mechanical advantage.	. The student will give an example of how friction reduces useful work.	. Set up a display or model using gears, pulleys, and belts.
E. Motion		
1. Motion must be described in reference to the position from which the observer is viewing the motion.	. The student will be able to interpret graphs describing motion.	
Newton's laws of motion are important in explaining the motion of objects.	. The student will be able to explain Newton's three laws of motion.	. Demonstrate Newton's three laws.
2. Velocity is the rate of motion in a certain direction.	. The student will differentiate between velocity and speed and work elementary problems.	. Work a few practical problems dealing with time of travel and distance with different speeds. . Chart distance-time graphs.
3. Acceleration is the rate of change of velocity.	. The student will be able to relate acceleration with stopping	. Make a chart of stopping distances for an automobile with

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	distances of an automobile traveling at various speeds.	different speeds. Ask driver education teacher or policeman to explain the chart to a class. . Prepare a report on ways jet and propeller-driven planes are decelerated on the ground.
Objects in "free fall" accelerate at a uniform rate of 9.8 m/s^2.	. The student will plan a demonstration to show understanding of "free fall."	. Use a stopwatch and rock to approximate the height of a building, hill, or tower.
F. Centrifugal and Centripetal Forces		
1. The force directed inward toward the center of a circular path, the center-seeking force, is the centripetal force.	. The student will be able to define centripetal and centrifugal forces and relate the principles to life situations.	. Illustrate centrifugal and centripetal forces by whirling a rubber ball to which a string has been attached.
2. The outward forces exerted by a revolving body away from the center of revolution is called centrifugal force and is a reaction force.		. Investigate road banking around curves and the motion of satellites.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
G. Mechanics of Fluid		
1. Liquids exert pressure which acts in all directions, is independent of the shape of the container, and is proportional to the height of its column times density.	. The student will state the relationship between height, density, and pressure upon objects in which fluids are placed.	. Figure the pressure on the bottom of the water tank in your school or town and ask someone to give the reading. . Pump up a bicycle tire and give student an opportunity to read the pressure guage.
2. Pascal's Law explains how pressure applied to a fluid is transmitted equally in every direction.		
Hydraulic devices are applications of Pascal's Law.	. The student will explain how hydraulic systems function.	. Borrow a hydraulic jack from a garage and demonstrate its force. . Get a student to report on the hydraulic brakes on the automobile.
3. Archimedes' principle defines the upward force exerted on objects placed in a fluid.	. The student will be able to explain how Archimedes' principle relates to ships, blimps, balloons, etc.	. Use a hydrometer to demonstrate specific gravity. . Demonstrate the flotation principle with an equal arm balance attached to a stand with different density weights

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		attached to the balance and lowered in water. Use an overflow can to demonstrate the volume of each object.
VI. HEAT A. The Nature of Heat Heat is a form of energy possessed by a substance because of the motion of its molecules.	. The student will relate heat and molecular motion by using the kinetic theory.	. Demonstrate sublimation and explain by kinetic theory.
B. Measurement of Heat and Temperature 1. Temperature is a measure of the average kinetic energy of molecules and is measured in degrees Celsius.	. The student will be able to differentiate between heat and temperature.	. Get students to measure the temperature of ice water, room temperature, and boiling water in °C. . Guide students in planning an experiment using ice cubes and water that will show the difference between heat and temperature.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Heat is measured in calories and is the total amount of kinetic energy in the molecules.	. The student will be able to calculate the quantity of heat in calories when given the necessary information.	. Place a small immersion heater or aquarium heater in a thermos bottle of water and calculate heat energy.
C. Heat Transfer Heat is transferred from one place to another by conduction, convection, and radiation.	. The student will illustrate the three methods of heat transfer by giving examples of each.	. Demonstrate conduction.
D. Change of State		
1. The addition of heat energy changes solids to liquids and liquids to gasses.	. The student will explain changes in state by using the kinetic theory.	. Demonstrate change in state.
2. The change of state produces refrigeration and heating.	. The student will have a general understanding of how a refrigerator or air conditioner works.	. Demonstrate the cooling effect of evaporation of alcohol. . Do research to learn how solar energy can be used to heat and cool buildings.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
E. Expansion and Contraction		
The size of volume of many substances expand when heated and contract when cooled.	. The student will explain expansion and contraction in terms of the kinetic theory.	. Compare the measurements of a copper and steel wire before and after heating.
VII. SOUND AND WAVE ACTION		
A. Nature of Sound		
1. Sound waves are compressional in nature and can be reflected, refracted, and diffracted.	. The student will be able to describe the nature of a longitudinal wave and explain why a medium is necessary for sound to travel.	. Use a slinky to demonstrate longitudinal wave action. . Place a vibrating tuning fork in water and show wave action. . Demonstrate wave actions with a ripple tank. . Use a vacuum pump, clock, and bell jar to illustrate what happens in a vacuum.
2. Sound waves must have a medium in which to travel.		
B. Characteristics of Sound		

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
1. Sound waves travel at different speeds in solids, liquids, and gases.	. The student will be able to explain why, in general, sound travels fastest in solids.	. Mark off a mile with the auto odometer. Use a starter's gun as a signal and figure speed in air. . Illustrate the transmission of sound through a solid, liquid, and gas.
2. A relationship exists between wave length, frequency, and pitch as well as between amplitude and intensity or loudness.	. The student will be able to demonstrate understanding of some characteristics of sound by describing the relationship among them.	. Using a tuning fork, demonstrate what is meant by frequency, pitch, and intensity.
C. Sound Phenomena		
1. The Doppler Effect is a change in pitch caused by motion of the source or the receiver.	. The student will be able to give an example of the Doppler effect.	. Ask students to observe change in pitch as a train approaches them or carry the class near a road and blow the horn steadily on approach and leaving.
2. Musical tones have a regular frequency and are produced by vibrating strings and air columns.	. The student will be able to distinguish between music and noise.	. Ask the band teacher or a music student to illustrate vibrating strings and air columns.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
VIII. LIGHT		
A. The Nature of Light		
1. Light, a form of radiant energy, acts as both a wave and a particle and travels at a speed of 3.0 x 10^8 M/S in a vacuum.	. The student will be able to relate wave length and frequency to different forms of radiant energy.	. Locate the position of visible light in the electromagnetic spectrum.
2. Light travels in a straight line and is transmitted through some materials.	. The student will differentiate between transparent and opaque materials.	. Demonstrate objects that are opaque, transparent, or translucent and discuss the effects of each. . Make models and charts to explain eclipses.
B. Reflection of Light		
1. When light is reflected, the angle of incidence is equal to the angle of reflection.	. The student will be able to draw a diagram depicting relationship between angle of incidence and angle of reflection.	. Trace ray diagrams by using pins and plane mirror.
2. A plane mirror produces a virtual, life-sized image by reflection.	. The student will be able to construct ray diagrams for plane and parabolic mirrors.	. Demonstrate concave and convex mirrors and discuss applications.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. A parabolic mirror can produce a real or virtual image.		
4. A reflecting telescope contains a parabolic mirror.	. The student will explain the light-gathering ability of reflecting telescopes.	. Research the design and manufacture of the Palomar telescope. . Ask an interested student or adult to explain how to make a reflecting telescope.
C. Refraction of Light		
1. The bending of light as it goes from one transparent material to another is called refraction.	. The student will be able to explain why light rays are bent.	. Use pins and prisms to illustrate refraction. . Place a pencil in a glass of water to show refraction.
2. Convex and concave lens refract light to produce desired optical effects.	. The student will explain the general case for convex and concave lens.	. Inspect and discuss optical systems in cameras, 16mm projector, etc.
3. Optical instruments use lens and mirrors for desired effects.	. The student will compare the lens of the human eye with that of a camera.	. Ask an optometrist to talk to the class about eye defects and corrective lens.
4. A prism or diffraction grating separates light into its various colors.	. The student will be able to explain how a prism separates	. Study the light that passes through a prism. Use a second prism and pass the light through

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	white light.	two prisms. Use colored plastic in parts of one prism. Discuss results. . Perform experiments with colored light filters to explain color.
IX. MAGNETISM AND ELECTRICITY A. Magnetism		
1. Lodestones are natural magnets which exhibit basic magnetic properties. The domain theory of magnetism holds that magnetic properties are electric in origin, resulting from the movement of electrons (charged particles) in atoms.	. The student will be able to list some properties of magnets.	. Display a chart comparing the properties of rubbed amber and lodestone.
2. All permanent magnets have two unlike poles--north and south.	. The student will recognize the laws of magnetism and application from demonstration.	. Try the effects of magnets on glass, tin, nails, etc.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
Like poles repel; unlike poles attract.		. Use a bar magnet to illustrate attraction or repulsion.
3. Magnets can be classified as bar, horseshoe, and electromagnets.	. The student will select the type of magnet from a table when given a type to select.	. Make a display of items containing permanent magnets.
Magnetism can be produced by an electric current.	. Given the necessary materials, the student will be able to construct a simple electromagnet.	. Use a copper wire, bar magnet, and galvonometer to show electromagnetism. . Research ways electromagnets are used.
4. Lines of force forming a magnetic field surround a magnet.		. Use an overhead projector, two bar magnets, iron filings, and plastic to demonstrate lines of force.
Electric current is produced when a wire cuts across magnetic lines of force.	. The student will explain the principle of an electric generator.	. Using a coil of wire connected to a galvanometer and a bar magnet, demonstrate the current flow. . Explain by visuals how an electric generator works.
B. Electricity		
1. Static electricity is produced by a gain or	. The student will define static electricity and list practical	. Sprinkle sawdust on a wool cloth and charge a balloon. Place the

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
or loss of electrons.	applications.	balloon near a pipe or radiator and explain the behavior of the dust.
Static electricity can be produced by friction.		. Get students to research electrostatic precipitators for dust removal.
2. Direct current (D.C.) is the flow of electrons through a conductor in one direction.	. The student will state how a storage battery works and list several practical applications.	. Make a simple cell with two unlike metals in dilute acid. Test with a voltmeter.
In alternating current (A.C.) electric charges move first in one direction and then in the other.	. The student will list advantages of alternating current over direct current.	. Invite a representative of the power company to come into the class to discuss community electrical service.
3. Conductors are substances through which electrons freely pass. Copper, silver, and aluminum are good conductors.	. The student will define and give practical application of conductors and insulators.	. Demonstrate conductors and insulators.
Conductors are used to transfer electricity from point to point.		. Make a display of conductors and insulators.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
Nonconductors (insulators) do not normally conduct charges. Rubber, plastics, glass, mica, and ceramics are good insulators.		
C. Electric Generators and Motors		
1. Electric generators produce electric energy from mechanical energy, and motors produce mechanical energy from electric energy	. The student will explain how a generator produces electricity.	. Visit a power plant or show a film on producing electricity.
Motors can be classified as A.C. or D.C. as to current source.	. The student will explain the principle of operation of a simple A.C. motor.	. Obtain discarded A.C. motors of the different types, disassemble the parts, and explain. . Make a display of the parts of the automobile electrical system or hold a class around an automobile. . Disassemble a used automobile alternator and explain its usage.
The power to turn generators is supplied by	. The student will be able to discuss various energy sources	. Research the current state of solar energy and project future

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
coal, oil, water, and nuclear fuel.	for power production giving advantages and disadvantages.	possibilities. . Play the Energy Environment Game (Alabama Power Company) to dramatize nuclear energy usage.
D. Measuring Electricity 1. The quantity and properties of electricity can be measured in standard units: ampere, volt, ohm, watt, kilowatt, kilowatt-hour. 2. Instruments have been devised to measure electrical units.	. The student will show his ability to read selected electrical measuring instruments and explain the meaning of the measurement.	. Ask students to check energy consumption of home appliances and make a poster. . Figure the KWH consumption of a selected home appliance and work problems. . Stress amperage, voltage, ohmage, and wattage as applied to home and automobile.
E. Ohm's Law Ohm's Law states that current varies directly	. The student will explain the relationship between	. Obtain an AC voltmeter and ammeter and switches and resisters of

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
with voltage and inversely with resistance measured in ohms.	resistances, voltage, and amperage.	known value; show the relatedness of current to voltage to resistance. . Measure the voltage in the wall plugs in the room.
F. Series and Parallel Circuits		
1. In a series circuit the current must flow through all parts of the circuit simultaneously.	. When a line drawing is presented, the student will be able to select the series from the parallel circuit.	. Obtain a series-type Christmas tree light and measure amperage and resistance. . Use miniature sockets, bulbs, wire, and batteries to set up and measure series and parallel circuits.
2. In a parallel circuit current flows through separate branches		
G. Controlling Electric Current		
1. A transformer steps up or down the voltage in a circuit.	. The student will select a step-down transformer by observing two drawings.	. Display small and large transformers and talk about usage.
2. Fuses and breakers are designed to prevent	. Student will select fuses of the proper size for home use.	. Make a display of different types and sizes of fuses and

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
circuit overload.		breakers.
3. Thermostatic devices control the operation of appliances.	. The student will explain the principle of operation of the thermostat for his home heating and cooling system.	. Heat a bimetallic strip to illustrate a thermostat. Obtain used home thermostats and automobile thermostats; discuss uses and applications.
4. Rheostats control speeds of operation of devices.	. The student will be able to identify the rheostat in a schematic diagram and state its use.	. Measure the current in a simple series circuit without and with a rheostat in the circuit.
H. Energy Conservation		
1. Fossil fuels are in short supply and are non-renewable.	. The student will name the fossil fuels and relate why there is a short supply.	. Display a world map showing coal, oil, and uranium sources.
2. Solar, wind, geothermal, tides, and nuclear sources must be developed to replace fossil fuels.	. The student will list advantages and problems with alternate energy sources.	. Assign reports on current research on the "state of the art" of alternate sources of energy.
3. There is a global energy shortage.		
4. Insultation helps reduce energy waste.	. The student will state the relation between amount of	. Ask a contractor to demonstrate and talk about insulation.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	insulation and energy consumption.	
5. Building design affects energy consumption.		Invite an architect to discuss design effects on energy consumption.
6. Appliance design affects energy consumption.	. The student will be able to select appliances that save energy.	. Do research on new ways appliances have been designed to save energy. . Study the cost per year to run home appliances and make a chart.
7. Energy consumption is related to life style.	. The student will relate how life style must be changed when energy is not available.	. Discuss and make posters on ways to save energy at home and school.

PHYSICS

INTRODUCTION

Physics is the science that deals with the properties of matter and the physical quantities and their interrelations which describe the physical state of that matter. Physics deals with mechanics, heat, light, sound, electricity, magnetism, atomic and nuclear structure, radioactivity, and their applications to our world.

During the past several years scientists and educators have proposed various changes in the physics curriculum of the American secondary school. Keeping this in mind we revise the physics curriculum to include innovations and meet the needs of students at the same time, thus incorporating the proven subject matter with the most useful and recent concepts of physics.

The objective is to present physics with a directness and simplicity that will enable students to achieve maximum comprehension. A real understanding of science is always highly motivating. Considerable content in the physical science area is now being taught in the elementary and junior high school. Even though this is the case, these previously learned concepts should be thoroughly reviewed if they are needed in order to build a firm basic foundation for the concepts of physics. After a thorough understanding has been achieved, a look at applications and recent developments is timely and meaningful.

The overall result is to present a physics course which will meet the needs of today's secondary school students by means of a logical organization in thoroughly understandable prose with experiments and demonstrations to illustrate and help conceptualize this prose.

PHYSICS

I. INTRODUCTION

  A. The Growth of Physics
  B. The Tools of Physics
  C. The People of Physics

II. MEASUREMENT OF PHYSICAL QUANTITIES

  A. Metric System
  B. Fundamental Units
  C. Relations among Physical Quantities and Derived Units
  D. Measuring Techniques

III. FORCE

  A. Definition and Units of Force
  B. Vector Representation of Force
  C. Examples of Force
    1. Gravitational
    2. Frictional
    3. Inertial
    4. Centripetal
    5. Reaction
    6. Bouyant
    7. Elastic
    8. Surface Tension
    9. Electro Static
    10. Magnetic
  D. Components of a Force Vector
  E. Resultant and Equilibrant of Concurrent Force Vectors
  F. First Condition of Equilibrium
  G. Non Concurrent Forces and Torque
  H. Second Condition of Equilibrium

IV. MOTION

  A. Quantities Describing Motion and Their Relationships
    1. Displacement
    2. Velocity
    3. Acceleration
    4. Relationships between displacement, velocity, and acceleration
  B. Laws of Motion
    1. Historical development
      a. Galileo
      b. Kepler
      c. Newton

- 2. Newton's Laws
    - a. Law of Inertia
    - b. Law of Acceleration
    - c. Law of Reaction
    - d. Law of Gravitation
- C. Types of Motion
  - 1. Uniform linear
  - 2. Uniformly accelerated
  - 3. Projectile
  - 4. Uniform circular
  - 5. Simple harmonic
  - 6. Rotational
- D. Momentum and Inelastic Collisions

V. ENERGY

- A. Work
- B. Potential Energy
- C. Kinetic Energy
- D. Power
- E. Simple Machines
- F. Relation to Motion
  - 1. Elastic collisions
  - 2. Uniform circular motion
  - 3. Simple harmonic motion

VI. HEAT AND THERMAL EFFECTS

- A. Heat and Temperature
  - 1. Temperature and temperature scales
  - 2. Internal energy and heat
  - 3. Difference between heat and temperature
  - 4. Mechanical equivalent of heat
  - 5. Heat capacity and specific heat
- B. Changes of State
  - 1. Solid to liquid
  - 2. Liquid to vapor
  - 3. Triple point
- C. Thermal Expansion
- D. Heat Transfer
- E. Laws of Thermodynamics

VII. WAVES

- A. Waves and Wave Characteristics
  - 1. Origin of waves
  - 2. Description and properties
    - a. Type
    - b. Propagation
    - c. Period, frequency, wavelength, and speed

        - d. Amplitude and energy
    - 3. Wave interactions
        - a. Reflection
        - b. Refraction
        - c. Diffraction
        - d. Superposition
- B. Sound
    - 1. Origin
    - 2. Description and properties
        - a. Type of wave
        - b. Propagation
        - c. Frequency, pitch, wavelength
        - d. Intensity and loudness
        - e. Standing waves, resonance, and harmonics
        - f. Doppler shift
    - 3. Musical instruments and scales
    - 4. The human ear
- C. Light
    - 1. Origin
    - 2. Theories of light
        - a. Particle
        - b. Wave
    - 3. Description and properties
        - a. Type of wave
        - b. Propagation
        - c. Frequency, wavelength, and speed
        - d. Refraction
        - e. Diffraction
        - f. Interference
        - g. Polarization
        - h. Color
        - i. Intensity
    - 4. Optical devices and image formation
        - a. Mirrors
        - b. Lenses
        - c. Combinations of mirrors and lenses
    - 5. The human eye
        - a. Image formation
        - b. Defects and corrections

VIII. ELECTRICITY

- A. Electrostatics
    - 1. Origin and types of electric charge
    - 2. Forces between charged objects
    - 3. Electric fields set up by charged objects
    - 4. Electrical potential energy and potential difference
    - 5. Storage of charge

B. Director Current
  1. Current and sources of continuous direct current
  2. Resistance
  3. Electrical potential difference
  4. Relationship between current, resistance, and potential difference
    a. Ohm's Law
    b. Parallel and series circuits
      i. For sources of potential
      ii. For resistors
      iii. For capacitors
      iv. Combinations of the above
    c. Electrical power
  5. Heating effects
  6. Chemical effects
  7. Magnetic effects
    a. Origin of magnetic fields
    b. Properties of magnetic fields
      i. Forces
      ii. Fields
      iii. Permeability
      iv. Induction
    c. Principle of operation of DC generators, motors, and meters
  8. Applications

C. Alternating Current
  1. Generators
  2. Measurement
  3. Phase relationships, vector diagrams, and relationships between the various electrical physical quantities
    a. Resistors
    b. Capacitors
    c. Inductors
    e. Combinations of the above
  4. Principle of operation of AC generators, motors, and meters
  5. Applications

IX. MODERN PHYSICS

A. Atomic Structure
  1. Models of the atom
    a. Thompson
    b. Rutherford
    c. Bohr
    d. Quantum view
  2. Electronic configuration
    a. Quantum numbers
    b. Physical properties

B. The Nucleus
  1. Radioactivity
    a. Types of radiation
    b. Biological effects
    c. Nuclear medicine
  2. Detection instruments
  3. Nuclear reactions
  4. Binding energies
  5. Fission
  6. Fusion
  7. Nuclear energy
    a. Fission reactors
    b. Breader reactors
    c. Fusion reactors
    d. Environmental concerns

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
I. INTRODUCTION		
A. The Growth of Physics	. The student will know the historical significance and evolution of physics.	. Discuss cases where one country's technical ability gave it an advantage over another country. . Discuss scientific breakthroughs and the subsequent advantages to society. . Discuss major research efforts and their spin-off products. . Discuss space-age problems and how the sciences are contributing to their solution.
B. The Tools of Physics	. The student will know the range and variety of tools needed to do experimental work.	. If possible, visit a major research effort and talk to scientists about their equipment and work.
C. The People of Physics	. The student will know some of the past and present personalities in physics.	. Read accounts of physicists and their work. . Invite a scientist from your area to talk about the challenges facing the next generation of scientists.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Talk about different types of scientific careers.
II. MEASUREMENT OF PHYSICAL QUANTITIES		
A. Metric System	. The student will know the metric system of units and be able to estimate physical quantities in terms of these units.	. Have the students practice thinking metric by asking them the length and mass of various objects. . Convert various rhymes/sayings to the metric system. . Convert a recipe to the metric system. . See how the metric system is displayed on commercial products.
B. Fundamental Units	. The student will know the fundamental units of length, mass, and time in terms of the metric system.	

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Relations among Physical Quantities and Derived Units	. Students will know that some physical quantities depend on other physical quantities in a particular manner, e.g. density, speed, etc.	. Several physical quantities such as density, weight, speed, acceleration may be mentioned; the student can try to determine what other physical quantities they depend on. . Show the students a simple pendulum, ask them to identify what physical quantities the period might depend on (they will probably say mass of the bob, length of the pendulum, amplitude of oscillation) and then get them to take data to see if they can discover the functional relationship among the various physical quantities mentioned and the period of the pendulum. . Give the students a series of cardboard disks and ask them to determine the functional relationship between the circumference and the diameter. In the process they will also discover why π is equal to 3.14.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	. The student will be able to express the units of different physical quantities in terms of fundamental units once they know the defining equation for that physical quantity.	. Give students the following equations in the order shown: $v = \frac{\Delta s}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$ $F = ma$ $w = FS$ $KE = \frac{1}{2}mv^2$ and then ask them to express each of these physical quantities in terms of fundamental units.
D. Measuring Techniques	. The students will know how to measure and record the physical quantities length, mass, and time. . The students will know how to handle data and determine an average, a percent probable error, and a percent difference.	. Using available measuring devices, have each student measure the length, mass, time, etc., of several objects or events. Compile all the data on a particular object and give it to one student who can then tabulate it and determine the average, a percent probable error,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		and a percent difference if another value is known or has been determined by another person.
III. FORCE		
A. Definitions and Units of Force	. The student will be able to identify the forces acting on an object.	. Set an object on a horizontal surface and identify all the forces acting on it. . Set an object on an inclined plane and identify all the forces acting on it. . Push an object across a horizontal surface and identify all the forces acting on it. . Push an object up an inclined plane and identify all the forces acting on it.
B. Vector Representation of Forces	. The student will be able to represent a force by a vector.	. Give the students several forces which they may represent as vectors.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
C. Types of Forces	. The student will be able to identify a large number of forces which exist in his everyday world and account for their existence. The forces considered should include gravitational, frictional, inertial, centripetal, reaction, bouyant, elastic, surface tension, electrostatic, and magnetic.	. Demonstrate each type of force listed and list examples of each type of force.
D. Components of a Force Vector	. The student will be able to resolve a force vector into its components.	. Determine the component of an object's weight down an incline and then use a spring balance to test your results.
E. Resultant and Equilibrant of Concurrent Force Vectors	. The student will be able to use graphical and analytical techniques in order to determine the resultant and equilibrant vectors.	. Theoretically (using graphical and analytical techniques) and experimentally (using commercial or rubber band force tables) determine the resultant and equilibrant of two, three, and four forces.
F. First Condition of Equilibrium	. The student will be able to state the first condition of	. Give students several forces and ask them to determine

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	equilibrium and use it to determine individual or equilibrant forces.	the equilibrant force using graphical and analytical techniques and the first condition of equilibrium. . Determine the components of the weight of an object on an inclined plane. Using a pulley system, counterbalance these forces. Now remove the plane; since the sum of the forces was zero, the object will remain in equilibrium.
G. Non Concurrent Forces and Torque	. The student will know the definition of torque and be able to determine the resultant torque on an object about a given axis due to a number of non concurrent forces.	. Set up several different torque situations and then determine the torque about a particular axis.
H. Second Condition of Equilibrium	. The student will be able to state the second condition of equilibrium and use it to determine individual forces, resultant forces, individual torques or resultant torques.	. Mount a meter stick horizontally, using an overhead pulley system. Apply several additional non concurrent forces to the meter stick. Theoretically, using the first and second conditions

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		of equilibrium, determine the magnitude and point of application of a vertical force which will bring the system into equilibrium. Experimentally test your calculations.
IV. MOTION A. Quantities Describing Motion 1. Displacement and position	. The student will be able to represent displacement as a vector and distinguish between displacement and position.	. Give the students several different displacements which they can plot as vectors and then use vector addition to determine the resultant displacement and position.
	. The student will be able to take data of an object's position at various times, correctly plot this data, and then use the plot to describe the object's motion.	. Hand-produce a different tape for several student groups which describes the linear motion of an imaginary object. For instance, you could say that the object traveled down the tape and made a dot every 1/10 of a second. Have the students take position and time data from the tape,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		make a position versus time plot, and then describe how the object changed its position as a function of time. Note an element of interest is obtained if the students' tapes are labeled as cars in a race; then everyone is anxious to see how his car performed and if he won the race. . On the quarter-mile track lay out 10 meter markers; have several students run around the track while other students take position and time data. Now plot position versus time for all the runners and discuss their motion. . Attach a blinking light to a moving object; take a time exposure photograph. From the photograph obtain position and time data, plot position versus time, and discuss the motion. . Paint a white spot on a moving object, use a strobe light, take a time exposure photograph; from the photograph

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		obtain position and time data, plot position versus time, and discuss the motion.
		. Use a sparking device or carbon paper and mechanical taper to make a permanent record of the position of the object at various times. From the tape obtain position and time data, plot position versus time, and discuss the motion.
		. View any available film loops which deal with position and time.
2. Velocity and speed	. The student will be able to represent velocity as a vector and distinguish between velocity and speed.	. Give students several different velocities which they can plot as vectors and for which they can give the corresponding speed.
	. The student will be able to take position versus time information of an object's motion in either data or graphical form and determine the average speed of the object over any	. Either from raw position and time data or a position versus time plot, determine the instantaneous speed of a moving object at several times. The race data mentioned above

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	time interval and the instantaneous speed at several instants.	may be used here.
	. The student will be able to plot correctly instantaneous speeds as a function of time and then use the plot to describe the object's motion.	. Plot instantaneous speed versus time and then compare results to answer questions about the race. The area under these plots may be used to relate speed to change in position.
		. Use time exposure photographs or paper tapes obtained as described above to make plots of instantaneous speed versus time and then discuss the motion of the object.
3. Acceleration	. The student will be able to represent acceleration as a vector.	
	. The student will be able to take instantaneous speed versus time information of an object's motion in either data or graphical form and determine the acceleration of the object at any time.	. From either raw instantaneous speed and time data or an instantaneous speed versus time plot determine the acceleration of a moving object at several instants and then make a plot of acceleration versus time. The area under these plots may be used to

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		relate acceleration to change in speed. The hand-produced race data or data from the photographs and tapes works well for this part also.
4. Relationships between displacement, velocity, and acceleration	. The student will be able to use the following relationships to analyze the motion of a moving object: $\overline{v} = \Delta s/\Delta t$ $\overline{v} = (v_I+v_f)/2$ $v_F = v_I + at$ $a = \Delta v/\Delta t$ $s = s_I + v_I t + ½at^2$	. Have the students work numerous problems dealing with the motion of objects. . View films concerning the motion of objects and the subsequent analysis.
B. Laws of Motion 1. Historical development of the study of objects motion	. The student will be able to trace the history of the development of the study of motion and point out the contributions of Galileo, Kepler, and Newton.	. Try to account for all of the motions observed using a geocentric model and a hilocentric model of the universe. . View films and read historical accounts of Galileo's trial.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Using stroboscopic pictures of an object traveling in an elliptical path, show that Kepler's law of equal areas is correct.
2. Newton's Laws of Motion	. The student will be able to state and cite evidence for the laws of inertia, acceleration, reaction, and gravitation.	. Demonstrate the law of inertia by breaking string, breaking a ball bat, pulling tablecloth out from under dishes, trying to stop large objects in motion. . Use lab carts (skate wheel type), air tracks, or whatever is available to collect data and verify the law of acceleration. . Sit on a skate board and fire a fire extinguisher to illustrate the law of reaction.
C. Types of Motion		
1. Uniform linear motion	. The student will be able to apply the relationships used to analyze motion and the laws of motion to different cases of uniform linear motion.	. Have the students work numerous problems dealing with motion and the forces causing it.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Two-dimensional motion	. The student will be able to separate two-dimensional motion into its components, use the relationships developed for one-dimensional motion to analyze each component of the motion, i.e., position, speed, and acceleration at any time, and then put the component information back together in order to describe the total motion of the object.	. Have the students work numerous two-dimensional projectile motion problems. . Simultaneously project an object horizontally outward and drop an object to show that their component motions are independent. . Shoot the monkey demonstration to show that in order to hit the monkey you must site the rifle directly at the monkey. . Roll a ball bearing down a small ramp and then across carbon paper over paper on an incline in order to obtain a two-dimensional record of motion which may be studied. . Take stroboscope pictures of objects moving in two dimensions and then analyze this motion using data obtained from the print.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. Uniform circular motion	. The student will be able to identify the source of the central force for various physical situations and use the relationships between the physical quantities involved to answer questions about the motion.	. Determine the speed limit for a flat curve. . Determine the speed limit for a banked curve. . Determine the tension in a string attached to a whirling rock. . Determine the mass, speed, or period of a satellite. . Determine the speed or radius for a loop-the-loop.
4. Simple harmonic motion	. The student will be able to determine the force constant of a spring.	. Take data of elongation versus load for a spring, plot this data, and determine the force constant of the spring.
	. A student will be able to analyze the motion of an object that is executing simple harmonic motion and relate the physical quantities position, speed, and acceleration.	. Using a reference circle, carefully develop the relationships between position, speed, and acceleration for simple harmonic motion. . Plot graphs of position, speed, and acceleration versus time for an object executing simple harmonic motion.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
D. Momentum and Inelastic Collisions	. The student will know the definition of momentum and how to use momentum to solve completely inelastic collision problems.	. Work numerous problems involving completely inelastic collisions. . Using billiard balls on a wire, air tracks, or dry ice pucks, cause different inelastic collisions, collect data, and show that momentum was conserved.
V. ENERGY		
A. Work	. The student will know the definition of work and be able to use it to determine the work done by the various forces in different physical situations.	. Work numerous problems to determine the work done by various forces in a physical situation. . Determine the work done to accomplish certain feats, e.g., push an object down the hall, walk or run up the stairs.
B. Potential Energy	. The student will know the definition of potential energy, how it is related to work, and be able to determine the gravitational potential energy of an	. Determine the difference in a student's gravitational potential energy between the bottom and top of a stairway and compare this to

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	object.	the amount of work he or she must do in order to climb the stairs. . View film loop on gravitational potential energy.
C. Kinetic Energy	. The student will know the definition of kinetic energy, how it is related to work, how it is related to potential energy, and be able to determine the kinetic energy of an object.	. Determine the change in kinetic energy of an accelerating object and compare this to the work done on the object during the acceleration. . Investigate conservation of energy in aircraft take-off.
D. Power	. The student will know the definition of power, how it is related to work, and be able to determine the power for various physical situations.	. Determine and compare the power output of a student walking and running up the stairs. . By running up the stairs, determine which student can put out the most power.
E. Simple Machines Theoretical mechnical advantage, actual mechanical	. The student will know the definition of theoretical mechanical	. For the various simple machines mentioned take data to

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
advantage, and efficiency of simple machines.	advantage, actual mechanical advantage, and efficiency for a simple machine, and be able to determine these quantities for levers, various pulley systems, belt drives, geared systems, incline planes, wedges, screws, hydraulic systems, and combinations of these simple machines.	determine their efficiency and then determine the force you would have to exert in order to accomplish some feat. . Look at examples of more complicated equipment and see how it consists of combinations of simple machines.
F. Relation to Motion The application of energy principles to the motion of objects.	. The student will be able to apply energy-related concepts to solve much more difficult problems dealing with collisions, uniform circular motion, rotational motion, and harmonic motion.	. View film loops on collisions that are not completely inelastic; take data from these loops to show conservation of momentum and non-conservation of energy. . Using a ballistic pendulum, determine the muzzle speed of a rifle. . Using billiard balls strung on a wire or an air track, predict the results of various collisions and then test these predictions.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Predict the results of a race between similar diameter hoop, cylinder, and sphere down an incline. Test your predictions.
VI. HEAT AND THERMAL EFFECTS		
A. Heat and Temperature		
1. Temperature and temperature scales	. The students will know the definition of temperature, the different temperature scales, and be able to read the different temperature scales and change temperatures from one scale to another.	. Construct and calibrate an air thermometer using the Celsius scale. . Make temperature measurements using thermometers with different scales, mathematically convert the scales, and compare.
2. Internal energy and heat	. The student will know the definition of heat, the units of heat, and be able to calculate the heat required to change the temperature of water by certain amounts.	. Calculate the amount of heat needed (in BTU's and calories) to raise the temperature in a certain amount of water by so many degrees.
3. Difference between heat and temperature.	. The student will be able to distinguish between the physical quantities heat and temperature.	

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
4. Mechanical equivalent of heat	. The student will know the definition of the mechanical equivalent of heat and be able to determine the change in temperature as a result of work.	. Do the Puluj-Searles experiment. . Fill a mailing tube with lead shot, theoretically determine the change in temperature of the shot after so many inversions, and then test your results experimentally.
5. Heat capacity and specific heat	. The student will know the definition of heat capacity and specific heat, be able to experimentally determine them for different objects, and be able to use them to make heat calculations.	. Experimentally determine the specific heat of different materials.
B. Changes of State 1. Latent heats and changes of state	. The student will know the definition of the latent heat of fusion, the latent heat of vaporization, and be able to use them to determine the amount of heat required for a phase change or to get a certain mass of a material from one temperature in one	. Calculate the amount of heat required to get 1 kg of water at -10°C up to steam at +110°C. . Experimentally determine the latent heat of vaporization and fusion.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	state to another temperature in another state.	
2. Vaporization and fusion curves and triple-point diagrams	. The student will know how to read vaporization and fusion curves and then obtain and interpret a triple-point diagram.	. Construct a triple-point diagram for water and carbon dioxide from their respective vaporization and fusion curves. . Demonstrate the influence of decreased pressure upon boiling point.
C. Thermal Expansion	. The students will know the definition of linear and volume coefficients of thermal expansion, be able to experimentally determine them, and then use them to predict expansion effects as a result of a change in temperature.	. Collect lengths of pipe as follows: aluminum pipes of the same length and thickness but different diameter, aluminum pipes of the same length and diameter but different thickness, aluminum pipes of the same thickness and diameter but different lengths, aluminum and brass or copper pipes of identical dimensions.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Devise an experiment using heated water and these pipes which will allow you to deduce what physical quantities the expansion is a function of. You can also determine the linear expansion coefficient for both materials. . Demonstrate expansion and contraction of solids using the ball and ring apparatus. . Look at several thermostats that use thermal expansion for control.
D. Heat Transfer	. The student will know the various methods of heat transfer and be able to determine the amount of heat conducted through a given material.	. Determine the amount of heat conducted through the window glass in your school on a cold day. . Do a cooling curve for Napthelene and determine the proportionality constant.
E. The Laws of Thermodynamics	. The student will know the first and second laws of thermodynamics and be able to	. Diagram and discuss how engines work.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	apply them to everyday situations.	. Diagram and discuss how refrigerators work.
VII. WAVES		
A. Waves and Wave Characteristics		
1. Origin and types of waves	. The student will know the source of various types of waves.	. Mechanically generate waves in springs, strings or ropes, water, metal rods, to illustrate how waves originate.
2. Description and properties of waves	. The student will know the following physical quantities and their relationships with respect to waves: speed of propagation, period, frequency, wavelength, amplitude, and energy.	. Attach a long spiral spring to a fixed object; by shaking one end of the spring, you can demonstrate all of the properties of waves and develop the relationship among frequency, wavelengths, and speed.
3. Wave interactions	. The student will know how waves interact with matter and with other waves in the processes of reflection, refraction, diffraction, and superposition.	. Generate water waves to illustrate the reflection, refraction, diffraction, and superposition of waves. . View film loops on wave interactions.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Use a mechanical vibrator to generate standing waves in a string and then collect data to investigate any relationships between the tension in the string, the density of the string, the length of the string, the frequency of the vibrator, and the speed of the waves down the string. . Use a tuning fork meeker burner to set up resonance in an air column. . Generate pulses from each end of the same spring to show superposition of waves. . Tie two different springs together and investigate the transmission of pulses down these two springs. . Develop blackboard diagrams in colored chalk for superposition of waves to produce standing waves.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
B. Sound		
1. The origin of sound	. The student will know what we call sound and its sources.	. Produce sound as many ways and over as wide a frequency range as possible; then discuss the source and how it generates the sound.
2. Description and properties of sound	. The student will know the following physical quantities and their relationships with respect to sound: speed of propagation, frequency, pitch, wavelength, intensity, loudness.	. Use two tuning forks to illustrate the superposition of sound waves. . Set up standing waves in different air columns, pipes, or solid rods; then discuss the relations among such physical quantities as length, frequency, wavelength, and speed.
	. The student will know the following sound phenomena, what produces it, and the relations among the physical quantities involved.	. Use sonar to determine the speed of sound in water. . Determine the frequency of an unknown source using standing waves in air columns.
3. Musical instruments and scales	. The student will know how various musical instruments produce sound.	. Using musical instruments, produce different notes and, if possible, view them on an oscilloscope.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Have the band instructor talk to the students about musical scales, harmony, discord, etc. . Visit a local church and carefully investigate a pipe organ.
4. The human ear	. The student will know how the ear hears.	. Determine the frequency range of hearing for various members of the class. . Determine the response time of hearing for various members of the class. . Use a sound meter to determine the intensity of various sounds.
C. Light 1. The origin of light	. The student will know how light originates.	. View various light sources, e.g., spectral tube, incandescent light bulbs, flourescent light bulbs, fire, sun; discuss how the light originates.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. The dual nature of light	. The student will know about the wave and particles theories of light including their success and/or failure in explaining the various properties of light.	
3. The description and properties of light	. The student will know how to describe light; the various proper ties of light, including type of wave, method of propagation, speed, frequency, wavelength, refraction, diffraction, interference, polarization, color, intensity, image formation; and how these properties are explained by the existing theories of light.	. Show light exhibiting the various properties listed and then try to explain what is happening in terms of the particle and wave theory. . Use ping pong balls to show that one can explain propagation, reflection, and intensity using the particle theory. . Use water waves to show that one can explain all of the listed properties (not a complete list) of light. . Use three overhead projectors and color filters to demonstrate the addition of colored light. . Use one overhead projector and color filters to demonstrate the subtraction of colored light.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Use polaroid sheets and an overhead projector to demonstrate the polarization of light. . Use calcite crystals and cellulose tape between crossed polarizers to demonstrate double refraction.
4. Principle of operation of optical devices	. The student will know about the following: plane, concave and convex mirrors, diverging and converging lenses, combinations of lenses, camera, microscopes, telescopes, projectors.	. Shine several light rays on mirrors and lenses in darkened rooms in order to trace them and see how images are formed. . Do ray tracing diagrams for mirrors, lenses, and combinations. . Investigate optical devices, make scale diagram, and do ray tracing to determine how these devices form images. . List everyday optical devices and explain their principle of operation. . Build and use a pinhole camera.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Discuss rainbow formation and mirages. . Using geometrical optics, determine the focal length of mirrors and lenses. . Determine the index of refraction of various materials. . Using a diffraction grating, determine the wavelength of an unknown light source.
5. Image formation of the eye	. The student will know how the eye forms images; the student will understand common eye defects and their correction.	. Using a water model of the eye and several corrective lenses, give the eye various defects, let the student analyze these defects, analyze the properties of the various corrective lenses, prescribe a corrective lens, and then see if his prescription corrects the defect.
VIII. ELECTRICITY		
A. Electrostatics		
1. The origin and types of	. The student will know of the	. Rub a glass rod with wool,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
charge	existence of electrostatic charge and how to produce it.	silk, or fur and then pick up little bits of paper. . Site other examples of electrostatic charge.
2. Forces between charged objects	. The student will know of the existence of electrostatic forces and how to calculate them, given the magnitude of the charge.	. Balance a 2" x 4" x 6' on an inverted watch glass and then cause it to rotate with a charged glass or lucite rod due to electrostatic forces. . Rub a balloon on your clothing and then hang it on the wall. . Show that like charges repel and unlike charges attract. . Cover two styrofoam balls with metallic foil, suspend them, charge them with the same type charge, and observe their mutual repulsion. Take data which will allow you to determine the charge on the balls. . Do standard electroscope experiments.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
3. Electric fields	. The student will know of the existence of electric fields and how to determine their magnitude and direction.	. Using a electrostatic generator, different shaped electrodes, an oil bath, carbon black, or grass seed, show the lines of force for different electric fields. . Calculate the magnitude of the electric field due to various charge configurations.
4. Electrical potential energy and potential difference	. The student will know the definition of these two physical quantities and how to determine them for several simple arrangements.	. Calculate the electrical potential energy of one charged object due to the presence of another charged object. . Using a power supply, different shaped electrodes, a voltmeter, probe, and a shallow water bath, determine and label the equipotential lines and then draw in the electric lines of force, determine the potential difference between various points, determine the electric field at various points and the force that would be felt by a charged particle at these points.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
5. Storage of charge	. The student will be knowledgeable about the storage of electric charge, capacitance, and how to determine it.	. Work problems involving capacitors in parallel and series.
B. Direct Current		
1. Current and sources of direct current	. The student will be knowledgeable concerning various sources of continuous direct current, shall know how to define electric current in terms of physical quantities charge and time, and shall know how to measure it using an ammeter.	. Construct and discuss the operation of a wet chemical cell, such as a Daniel cell. . Take apart and discuss the operation of a dry cell. . Construct and discuss the operation of a photocell. . Construct and demonstrate a theromocouple.
2. Resistance	. The student will be knowledgeable concerning electrical resistance and the physical quantities that it depends on and will know how to measure resistance using an ohmeter or Wheatstone Bridge.	. After an introduction to electrical potential difference and the relationship between current, resistance, and potential difference, students may use a Wheatstone Bridge to determine experimentally the dependence of resistance on length, cross sectional area,

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		temperature, and type of material.
3. Electrical potential difference	. The student will be knowledgeable concerning electrical potential differences and will know how to measure it using a voltmeter.	
4. Relationship between current, resistance, and potential difference	. The student will know Ohms Laws and will be able to experimentally verify it.	. Using a single resistor, power supply, or several batteries, voltmeter, and ammeter, record the potential difference across the resistor and the current through the resistor for different sources so plot V versus I, see that this V/I is a constant, and show that this constant is equal to the resistance.
	. The student will know how the circuit elements resistance, capacitors, and batteries work in parallel and series and will be able to determine such things as the following: total source of potential, total resistance, total capacitance,	. Connect combinations of resistors in parallel and series across a battery, record V and I at various points, and then develop an expression for how resistors behave when connected in parallel and series. . Repeat the above for capacitors

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	potential difference between any two points in the circuit, and current at any point in the circuit.	and do similar investiaations for batteries.
	. The student will know how to determine the electrical power consumed by a circuit component.	. Calculate the power consumed by various electrical appliances in a 24-hour period; then figure out your daily power bill and compare it to parents' monthly power bill.
5. Heating effects of electricity	. The student will be knowledgeable concerning the heating effects of electricity including what physical quantities affect the amount of heat produced and will know how to take data and calculate the amount of heat produced.	. Cook a hot dog using a suicide cord plugged into an AC outlet. . Experimentally determine the mechanical equivalent of heat by passing current through a coil of wire in water in a calorimeter cup. . Discuss electrical instrumentation which uses the heating effects of electricity.
6. Chemical effects of electricity	. The student will be knowledgeable concerning the chemical	. Demonstrate the electrolysis of water.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	effects of electricity including electrolytic cells, electrolysis, and electroplating.	. Do some electroplating. . Experimentally determine the electrochemical equivalent of copper.
7. Magnetic effect of electricity	. The student will know how to detect the presence of a magnetic field and determine its direction.	. Demonstrate a natural magnet. . Use a compass to detect the presence of and determine the direction of a magnetic field. . Have the students map magnetic fields for different pole configurations using iron filings.
	. The student will know that magnetic poles exist, will know how to determine the type of a magnetic pole, and will know how it will affect another pole.	. Using two magnets, demonstrate that the ends of the magnet behave differently (name them conventionally N and S seeking). . Demonstrate that a magnetic field exists around a current-carrying wire.
	. The student will know that electric currents create magnetic fields, be able to predict the direction of such fields, and calculate their strengths for certain simple arrangements (Amperes Law).	. Build a solenoid and map its field with an air core and with an iron core center.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		. Build an electromagnet.
		. Place a long wire between the poles of a strong horseshoe magnet; when a large current is passed through the wire, it will be forced out of or into the magnet.
		. Pass a current through two long parallel wires to demonstrate attraction and repulsion.
	. The student will be knowledgeable concerning magnetic induction, shall know Lenz's law, and be able to apply it to simple arrangements in order to determine the direction of induced fields and currents.	. Use a battery and one coil to induce current in another coil. Put a sensitive galvanometer in with the second coil so that the induced currents and their direction may be noted.
		. Build a small transformer. Predict V_s, I_s, P_s and then experimentally determine V_s, I_s, P_s and the efficiency.
	. The student will know how to generate direct current electricity.	. Connect a long wire to a sensitive galvanometer. When the wire is passed through the poles of a strong horseshoe magnet, a current will register.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
		Move the wire back and forth to show the generation of alternating current generator and show what modifications must be made in order to generate DC.
	. The student will know how DC meters and motors work.	. Starting with a galvanometer, construct and use DC ammeters and voltmeters capable of making measurements over various ranges.
8. Application of direct current electricity	. The student will be knowledgeable concerning the present-day use of direct current electricity and its advantages/disadvantages over alternating current.	. Build a small DC motor. List and discuss present-day uses of direct current electricity.
C. Alternating Currents		
1. Generation of alternating current electricity	. The student will know how AC is produced.	. Using a strong horseshoe magnet and a coil of wire attached to a sensitive galvanometer, generate AC. . Investigate a model AC generator and discuss its operation.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
2. Measurement of alternating current electricity	. The student will know how to measure the current and potential difference in an AC circuit and then calculate the resistance. He shall also understand the principal of operation of an AC ammeter and voltmeter.	. Using a 60 Hertz 40 volt source, measure the current through and the potential drop across a resistor (200 Ω) and then calculate the resistance. . Examine AC meters and discuss their operation.
3. Phase relationships, vector diagrams, and relationships between the various electrical physical quantities	. The student will know how to construct alternating current diagrams and from them determine the phase between the current and resultant voltage for resistors, capacitors, inductors, and various simple combinations. The student will also be able to determine the relationships between the various electrical physical quantities from these vector diagrams.	. Hook up the following simple series circuits using a resistor, capacitor, coil, and a 60 Hertz 40 volt source: source and capacitor source and coil source, capacitor, resistor source, coil, resistor source, coil, capacitor source, resistor, coil, capacitor . Take data, construct vector diagrams, determine functional relationship between variables, and determine the phase angle for each of the above simple series circuits.
4. Principle of operation of AC generators,	. The student will be able to explain how AC generators,	. Investigate models AC generators and discuss how they work.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
motors, meters	motors, and meters work.	. Investigate AC motors and discuss how they work. . Build a small AC motor. . Look at AC meters and discuss how they work.
5. Applications	. The student will be knowledgeable concerning the present-day use of alternating current electricity and its advantages/disadvantages over direct current.	. List and discuss present-day uses of alternating current electricity. . Make a wiring diagram for a house. . Wire a fuse box for a specified house and number of appliances.
IX. MODERN PHYSICS		
A. Atomic Structure		
1. Models of the atom	. The student shall be knowledgeable concerning the following models of the atom: Thompson, Rutherford, Bohr, and Quantum.	. View historical films on the models of the atom.
2. Electronic configuration	. The student shall be able to add electrons one at a time to an atom, determine the	. As successive electrons are added, have students determine the electronic configuration

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
	possible quantum numbers for each electron, and comment concerning the physical properties of the atom.	and try to predict the physical properties. Then compare answers to findings on the periodic chart.
B. The Nucleus		
1. Radioactivity	. The student will know the different types of radiation and their characteristics.	
2. Detection of radiation	. The student will be knowledgeable concerning the principles of detection of radioactive particles.	. Build a Cloud Chamber and view Alpha particles. Use a G-M tube to detect the presence of radiation and its penetrating power.
3. Nuclear reactions	. The student will be able to do simple nuclear reactions and predict daughter nuclei.	
4. Nuclear binding energies	. The student will be able to calculate nuclear binding energies.	. Calculate binding energies and make a plot of binding energy versus atomic number.
5. Fission	. The student will know what is meant by nuclear fission and be able to determine the amount of energy available from a particular fission event.	. Do the fission reactions which are applicable to fission-type nuclear power plants.

CONCEPTS	DESIRED LEARNING OUTCOMES	ACTIVITIES
6. Fusion	. The student will know what is meant by nuclear fusion and be able to determine the amount of energy available from a particular fusion event.	. Do the fusion reactions that occur on the sun. . Do the fusion reactions that are feasible for power production.
7. Nuclear energy	. The student will know the principle of operation of a nuclear power plant.	. Construct block diagrams for a fission and fusion plant.
	. The student will be aware of the environmental problems associated with nuclear power plants.	. Visit a nuclear power plant. . Have a guest lecturer who has a background in environmental science.

ALTERNATIVE CONTENT AREAS

This section provides additional courses that may be offered at the option of the local school system. Since only one unit of science is required for graduation, any course in the curriculum would fulfill this requirement; therefore, it is suggested that no course be considered required. It is recommended that the entire science curriculum be considered an elective program.

Specific grade levels are not provided, but they are deemed most appropriate for inclusion in grades nine through twelve.

Advance Placement Program courses are offered by several school systems and are considered as part of the alternative content area.

ADVANCED BIOLOGY

To allow for flexibility in developing a course to meet the needs of the local learners and utilize local resources, it is suggested that a course in advanced biology be considered. This course could be a full-year course, a semester course, a single mini-course, or a set of mini-courses.

Topics in advanced biology could be extensions of material introduced in previous life science studies. The organization could be flexible to range from research to small seminar to lab-oriented classroom. This course would lend itself to include current relevant problems in the life science area.

Mini-courses could be developed to include any one or as many of the following as desired. Creativity can be used to develop other subject areas for mini-courses.

1. Forestry
2. Entomology
3. Genetics
4. Anatomy and Physiology
5. Microbiology
6. Botany or Related Plant Studies
7. Horticulture
8. Ecological Systems
9. Embryology
10. Modern Trends in Medical Research
11. Mental Health
12. Social Problems
13. First Aid and Safety
14. Animal Health Care and Population Control
15. Outdoor Recreation and Safety
16. Cancer
17. Birds
18. Heart Attacks
19. Plants Indoors
20. Energy Education
21. Oceanography
22. Marine Biology

ADVANCED CHEMISTRY

Advanced chemistry should utilize the student's special interest in technical or scientific areas. Its content should aim toward CLEP or advanced placement for college entrance or technical preparation. Some topics which might be included are in-depth studies in the following:

1. Thermochemistry
   (Enthalpy, Entropy, and Free Energy)
2. Chemical Kinetics--Rates of Reactions
3. Chemical Equilibrium
4. Acid-Base Theories
5. Oxidation--Reduction
6. Modern Atomic Theory (including Quantum Numbers and Molecular Orbital Bonding)
7. Organic Chemistry
8. Biochemistry
9. Chemistry of the Stars
10. Environmental Chemistry
11. Nuclear Chemistry
12. Coordination Compounds
13. Mathematics for Chemistry
14. Quantitative and Qualitative Analysis

Individual laboratory and independent study activities should occupy a major part of the course.

AEROSPACE EDUCATION

INTRODUCTION

This century is often referred to as "The Space Age," for during this time period man has learned more about space and flight than in all of the preceding years combined.

It is very important that boys and girls have as a part of their education an opportunity to learn the importance of space and flight to human welfare. It is also important that they be provided an opportunity to explore the many possibilities for careers in aerospace.

Many students are interested in pursuing the study of aerospace to a depth appropriate to their individual abilities. A course should be developed which will encourage this interest.

There are many possibilities for field trips, speakers, films, and other experiences in aerospace education. Most cities and towns have airports. An opportunity to examine aircraft and visit control facilities can be an invaluable teaching-learning experience, for it is very important that students have first-hand experience with aircraft.

Alabama has an outstanding museum in the Alabama Space and Rocket Center in Huntsville. A visit to the Center and to the historic NASA Marshall Space Flight Center is an extraordinary opportunity for learning.

There are several United States Air Force bases and several aerospace industries in Alabama. Tours of these facilities, with special emphasis upon appropriate topics, can be arranged. Visits to planetariums may be feasible, too.

Many communities have people who are or have been involved with aerospace. Some of these people are excellent speakers and are quite willing to speak to groups of students.

There are many free films on aerospace available. Among the outstanding are the NASA films which may be obtained from the Office of Public Affairs, Marshall Space Flight Center, Alabama. Aerospace industries and commercial aviation corporations have films which are available free of charge to education.

Opportunities for projects and papers are numerous in the field of aerospace, for it includes so many areas.

General Objectives for Aerospace Education

To develop an awareness of the needs and implications of aerospace and its impact on society.

To motivate and stimulate interest in and understanding of the scientific and social advancements being made by mankind as a result of aerospace research and development.

To develop the abilities to speak and write about aerospace education in a meaningful manner.

To create an interest and appreciation on the part of the student for aerospace literature and related materials and to assist him/her in the interpretation of these.

To prepare students so that they may participate in a society strongly influenced by the growth of aviation and space exploration.

To furnish students opportunities for career exploration in aerospace.

To develop an understanding of the basic principles of aerodynamics.

To develop an understanding of the basic principles of rocketry.

To develop an understanding of the nature of space.

Aerospace Education--One-Semester Course
(may be offered on middle school or upper secondary level)

A one-semester course in aerospace education should be general and exploratory. Areas which should be included are:

- History of Flight
- Benefits of Aerospace to Mankind
- Air and Space Flight

Career opportunities in aerospace should not be treated as a separate topic. Instead, this should be emphasized and explored throughout the course.

Aerospace Education--Two-Semester Course

A two-semester course in aerospace education should include as minimum the following topics:

- Aerospace and Society (The Importance of Air and Space Travel to Humans)
- Basic Principles of Flight
- Aircraft Propulsion Systems
- Basic Meteorology
- Aerial Navigation
- Rocketry and Space Flight

Career opportunities in aerospace should not be treated as a separate topic. Instead, this should be emphasized and explored throughout the course.

CONSUMER BIOLOGY

Consumer biology should utilize laboratory experiences and current publications in order to study the use of the principles of biology in the personal lives of the learner including consumer and career application.

The length of the course should depend upon the available resources (human and financial).

Some of the topics that might be included are:

1. Organic Gardening
2. Heart Disease
3. Cancer
4. Food--Is There Enough?
5. Truth in Advertising
6. Population Study
7. Social Implication of Biology
8. Radioactivity and People
9. Flora Culture as a Hobby
10. Tropical Fish as a Hobby
11. Caring and Feeding Pets
12. House Plant and Lawn Growth Care

CONSUMER CHEMISTRY

Consumer chemistry should utilize laboratory experiences and current publications in order to study the use of the principles of chemistry in the personal lives of the learner including consumer and career applications.

The length of the course should depend upon the available resources (human and financial). Some of the topics that might be included are:

1. Chemistry of Food and Food Preservatives
2. The Future of Our Mineral Resources
3. Environmental Chemistry--Recycling
4. Environmental Chemistry--Soil
5. Environmental Chemistry--Water
6. Environmental Chemistry--Air
7. Cosmetic Chemistry
8. Horticulture Chemistry
9. Medical Chemistry
10. Electro Chemistry
11. Aerospace
12. Industrial (dyes, paint, etc.)

CONSUMER PHYSICS

Consumer physics should utilize laboratory experiences and current publications in order to study the use of the principles of physics in the personal lives of the learner including consumer and career applications.

The length of the course should depend upon the available resources. Some of the topics that might be included are:

1. Technology of Communication System
2. People and Machines
3. Electricity in the Home
4. Radioactivity and People
5. Nuclear Energy
6. Geophysics
7. Electronics as a Hobby
8. The Physics of Musical Instruments
9. Biophysics
10. Work, Power, and Energy

ENVIRONMENTAL EDUCATION

Environmental Education should be a part of every science course or, perhaps more appropriately, a part of every course, for it is so essential to the well being, perhaps the very existence, of humankind.

If a separate course is to be offered, it should include, as a minimum, the following broad objectives:

- Appreciation for the environment in which one lives.
- Understanding of the importance of certain physical factors to organisms in an environment.
- Understanding of the interrelationships of organisms in an environment.
- Understanding of the interrelationships of humans specifically and their environments.
- Understanding of what may be done by an individual or group to improve an environment.
- Investigation of current laws and legislation which affect a particular environment.

MARINE SCIENCE

A Marine Science course for secondary students should involve experience in a Marine environment as much as is possible. It is essential that students spend at least some time in such a setting. This course should include, as a minimum, the following broad objectives:

- Appreciation for the sea and its contribution to all living things.
- Understanding of the importance of the sea to humankind.
- Understanding of the interrelationships among organisms in the Marine environment.
- Understanding of the importance of certain physical factors which affect organisms in the Marine environment.
- Awareness of dangers, such as pollution to Marine life.
- Awareness of the feasibility of increasing humankind food supplies from the sea.

MINI-COURSES

Certain guiding assumptions were used in developing the idea of using mini-courses from multiple areas of science as alternative courses. They are as follows:

1. Students should have some opportunity to select from a group of curriculum offerings.
2. Part of the curriculum should be organized into courses smaller than one quarter of one-year blocks of time.
3. Curriculum offerings should reflect the emphasis on the individual learner.
4. Students should be provided some experiences that are interdisciplinary in nature.
5. Some experience should be directed to the immediate concerns and interests of learners.
6. Curriculum offerings should reflect the resources of the area.

Some of the topics for mini-courses include:

1. Care of My Body
2. Diseases and Man
3. Study of Nature and Cultured Plants
4. Study of Local Wild Animal Life
5. How Can We Conserve Energy?
6. Pollution--What Is It?
7. Landscape Formation
8. Oceans, Lakes, and Rivers
9. Weather Phenomena and Forecasting

10. The Stars, Sun, and Other Neighbors of Earth
11. Man's Use and Abuse of The Land
12. Space Exploration
13. Study of Domesticated Animals
14. Lapidary Hobbies
15. Photography
16. Environmental Conflicts of Interest
17. Parapsychology
18. High Fidelity Sound and Acoustics
19. Optics
20. Electronics as a Hobby
21. Aviation Education
22. Science and Superstition
23. Study of Helpful and Harmful Insects
24. Embryology
25. Stars and Galaxies
26. Weather Observations and Instruments
27. Weather Mapping and Forecasting
28. Marine Science
29. Physical Oceanography
30. Mineral and Fossil Fuels

NATURE AND FUNCTION OF THE HUMAN BODY

The teaching of any science course should meet those particular objectives which will best satisfy the needs of individual learners living in a particular environment. In a specialized subject, such as anatomy or physiology, the major goal should be to furnish the learners with information about themselves that will aid them in their daily lives. It is hoped that the course will lead to the application of the principles of physiology to the fields of public health, nutrition, and the effects of drugs and narcotics.

The course should be organized so that it follows a logical sequence from system to system until the ten body systems have been covered, with emphasis on the diseases and disorders of the body.

It is suggested that this course be a year in length.

APPENDIX A

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APPENDIX B

Key to National Curriculum Projects

Often in studying science curriculum materials and surveying literature, acronyms are used but are not explained. The following list would be helpful in a study of national programs:

I. Elementary Grades 1-8

CIS	Concept in Science--Harcourt Brace Jovanovich
COPES	Conceptually Oriented Program in Elementary Science--New York University
ESCP	Earth Science Curriculum Project--Houghton MIfflin
ESLI	Elementary Science Laboratory Investigation--Rand McNally
ESS	Elementary Science Study--McGraw-Hill
IET	Interaction of Earth and Time--Rand McNally
IIS-Life	Ideas and Investigation in Life Science--Prentice Hall
IMB	Interaction of Man and the Biosphere--Rand McNally
ISCS	Intermediate Science Curriculum Study--Silver Burdett
MAPS	Modular Activities Program in Science--Houghton Mifflin
PCP	People Concepts Processes--McGraw-Hill
SAPA	Science--A Process Approach--Ginn and Company
SCIS	Science Curriculum Improvement Study--Rand McNally
STEM	Space, Time, Energy, Matter--Addison-Wesley
TSM	Time, Space, and Matter--McGraw-Hill

II. Secondary Grades 9-12

AB	Action Biology--Allyn Bacon
BSCS	Biological Sciences Curriculum Study--Prentice Hall, Rand McNally, Houghton Mifflin
CBA	Chemical Bound Approach--McGraw-Hill
CHEMS	Chem Study--Chemical Education Materials Study--Prentice Hall, D.C. Heath, Houghton Mifflin
ECCP	Engineering Concepts Curriculum Project--McGraw-Hill
IAC	Interdisciplinary Approaches to Chemistry--Harper Row
IIS Biology	Ideas and Investigations in Biology--Prentice Hall
IIS Physical	Ideas and Investigations in Physical Science--Prentice Hall
IME	Interaction of Matter and Energy--Rand McNally
IPS	Introductory Physical Science--Prentice Hall
ISIS	Individualized Science Instructional System--Ginn and Company
MMW	Man-Made World--Houghton Mifflin
PP	Project Physics--Holt, Rinehart and Winston
PSNS	Physical Science for Non-Science Students--Wiley
PSSC	Physical Science Study Committee--D.C. Heath

Courses of Study and/or Curriculum Guides from the following states:

California. Science Framework for California Public Schools, Kindergarten - Grades One Through Twelve. California State Department of Education.

Connecticut. Science Educator's Guide. State Department of Education.

Delaware. The History of Science Education. State Department of Public Instruction.

Archaeology, Delaware, Student Activities and Teacher's Guide. Delaware State Department of Public Instruction.

Georgia. DeKalb County School System Course Guides, Elementary-Grades 1-2-3.

DeKalb County School System Course Guides, Elementary-Grades 4-5-6-7

Indiana. Guidelines for Indiana School Science Program K-12. Department of Public Instruction.

Kentucky. Science Course of Study.

Louisiana. Career Education Resource Guide for Physics.
Career Education Resource Guide for Biology.
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Weather and Climate, Experimental Syllabus, Block H, Science 7, 8, 9.
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